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Power for Bottle Making

NATURAL GAS IS USED AS FUEL IN THE CHAS. BOLDT CO.'S PLANT; GAS ENGINE DRIVEN GENERATORS SUPPLY ALL POWER FOR MAKING BOTTLES BY MACHINERY

FROM PREHISTORIC times the art of glass making has been held more or less of a secret, and to the layman considerable mystery surrounded the industry. During the past decade, however, manufacturers have placed it in a class with other scientific industries, and advancement, particularly in bottle making, has been marvelous. Each process of manufacture, however, still gives best results when the proper mixture of ingredients has been worked out to suit the particular case and chemical analysis does not reveal just what proportions were used in the mixture, so that the method of determining the proper mixture is largely one of trial until best results are obtained.

Whereas formerly the manufacture of bottles involved a great amount of skilled manual labor, the process today is carried on automatically from the mixing of the ingredients to the point of inspection, and a great amount of power is consumed in driving the machinery.

What is reputed to be the most complete and up-to-date bottle factory in the world for the manufacture of whisky bottles was put into operation last September at Huntington by the Chas. Boldt Co., of Cincinnati, and presents a number of features in arrangement of apparatus and choice of equipment which prove most interesting.

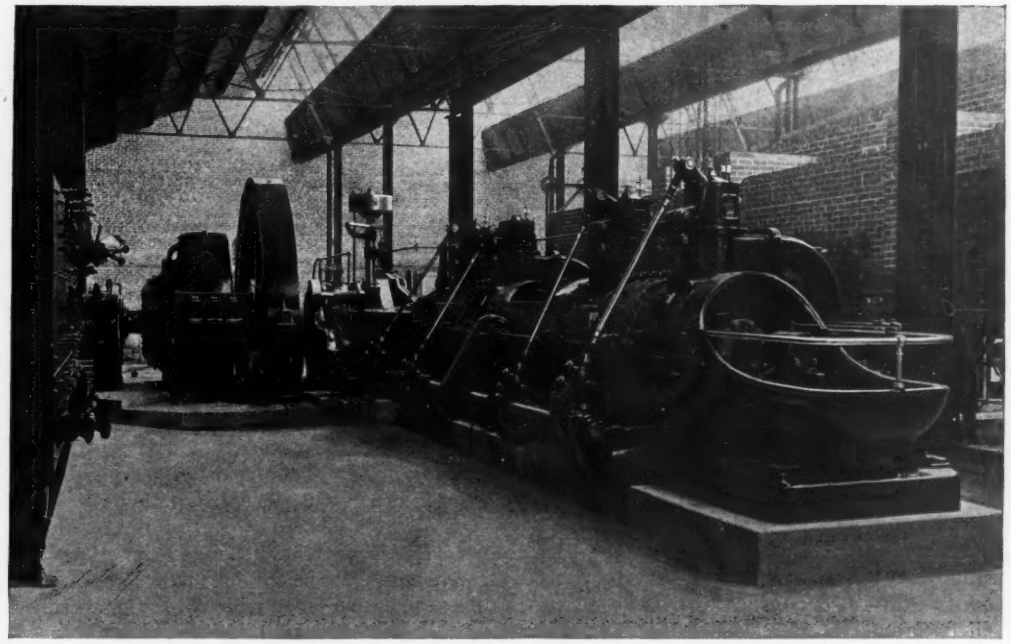


FIG. 1. ONE OF THE GAS ENGINE DRIVEN GENERATING UNITS IN THE CHAS. BOLDT CO.'S PLANT

Materials used in the manufacture of glass, such as sand, lime, soda, etc., are received at the siding of the

plant in box cars, which are unloaded by means of a power-operated drag shovel. This shovel scrapes the material out of cars into a hopper leading to the boot of bucket elevator. In order that this one elevator might serve all the storage bins, 5 in number, each having a capacity of approximately 500 tons, it is arranged to run on a single rail at ground level and be guided by another along the top of the tanks. It is moved from one position to another by power. The elevator is 65 ft. 6 in. centers and is composed of rubber belt and 10 by 6-in. buckets at intervals, the belt being 12 in. wide.

until the batch is thoroughly mixed and then the car having meanwhile been spotted over a discharging hopper, a door is opened in the drum and contents dropped in hopper. From here it is fed by means of a cast-iron screw onto a 20-in. rubber belt conveyor 38 ft. 9 in. centers, which brings it into the building and delivers it to the foot of the belt and bucket elevator. This elevator, 40 ft. 6 in. centers, composed of 12-in. rubber belt and 10 by 6-in. malleable iron buckets, elevates the material and discharges it to a 338 ft. 6 in. centers, 20-in. rubber belt conveyor running over the batch bins. This conveyor is provided with a movable self-propelled belt trip-

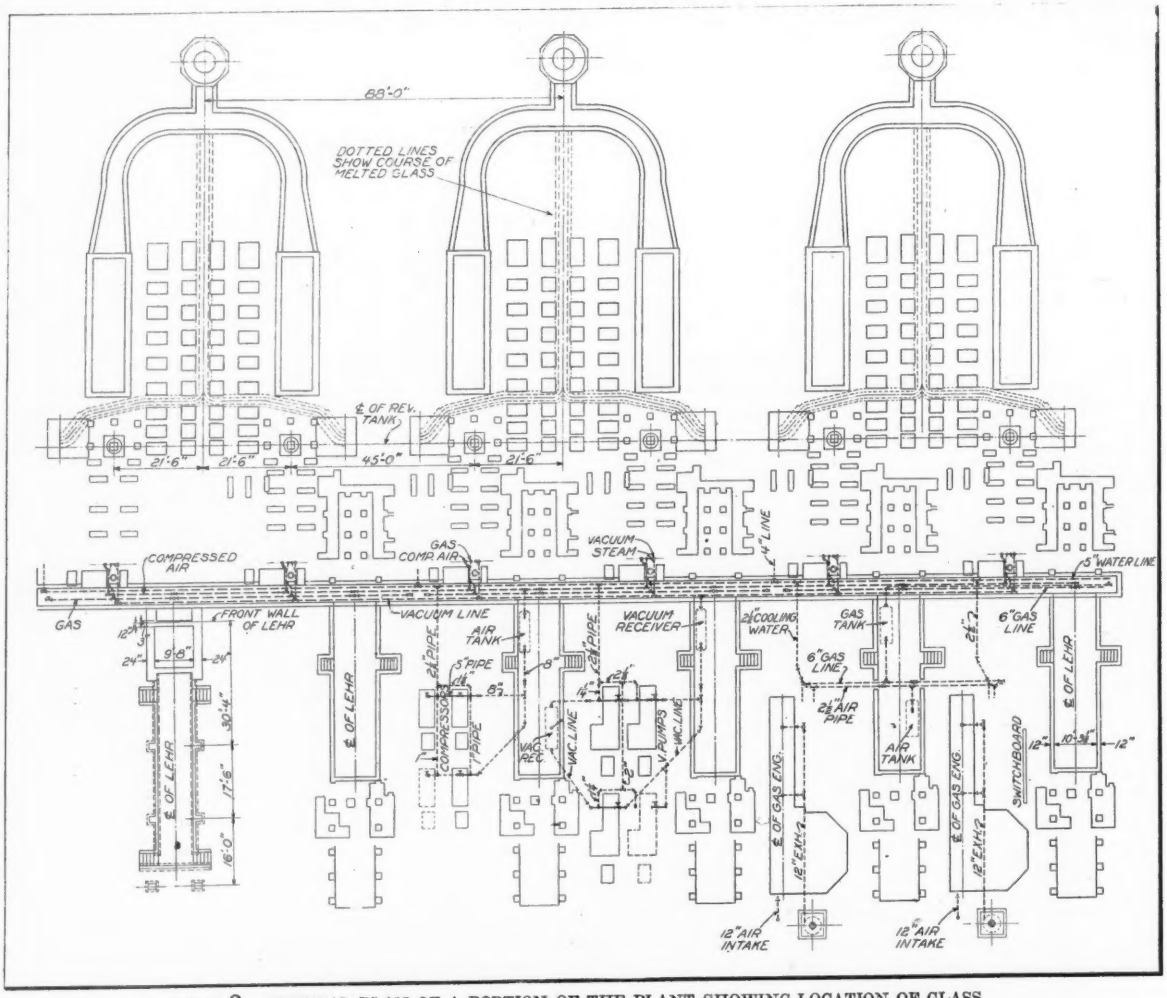


FIG. 2. GENERAL PLAN OF A PORTION OF THE PLANT SHOWING LOCATION OF GLASS FURNACES, BOTTLE MACHINES, MAIN PIPING AND POWER PLANT MACHINERY

A hammer crusher is used to break up the refuse glass or cullet and it is elevated and stored in a bin located in line with raw material bins. The elevator, which is 40 ft. 9 in. centers, consists of 12-in. rubber belt with 10 by 6-in. malleable iron buckets at intervals.

Underneath the storage bins, a car runs which has a rotary mixing drum. Into this drum a batch is made up by drawing from the bins some of each kind of material, the exact amount being determined by a 6-beam weighing scale, one beam being used for each sort of material. When the drum is filled it is rotated by power per so as to distribute the material throughout the long batch bins. From the batch bins the material already mixed is drawn off as required to the melting furnaces.

All this conveying machinery is the product of the Link-Belt Co., of Philadelphia.

This new factory covers an approximate area of 4 acres with the glass furnaces and bottle machines in a building of lantern construction and monitor roof, while the power plant apparatus and annealing ovens or lehrs, as they are called, are in adjoining alleys provided with a factory roof of the saw tooth type, putting the entire

plant under one roof with no partitions and providing a maximum amount of natural light and ventilation. On 2 sides of the plant are railway sidings upon which the raw materials and finished products are conveyed.

Outline of Process

Before taking up a description of the power equipment, a short outline of the bottle making process as carried on here will aid the reader to judge the character of the demands put upon the plant.

When the glass has been melted in the furnace it flows to a refiner, thence to revolving pots, 2 of which

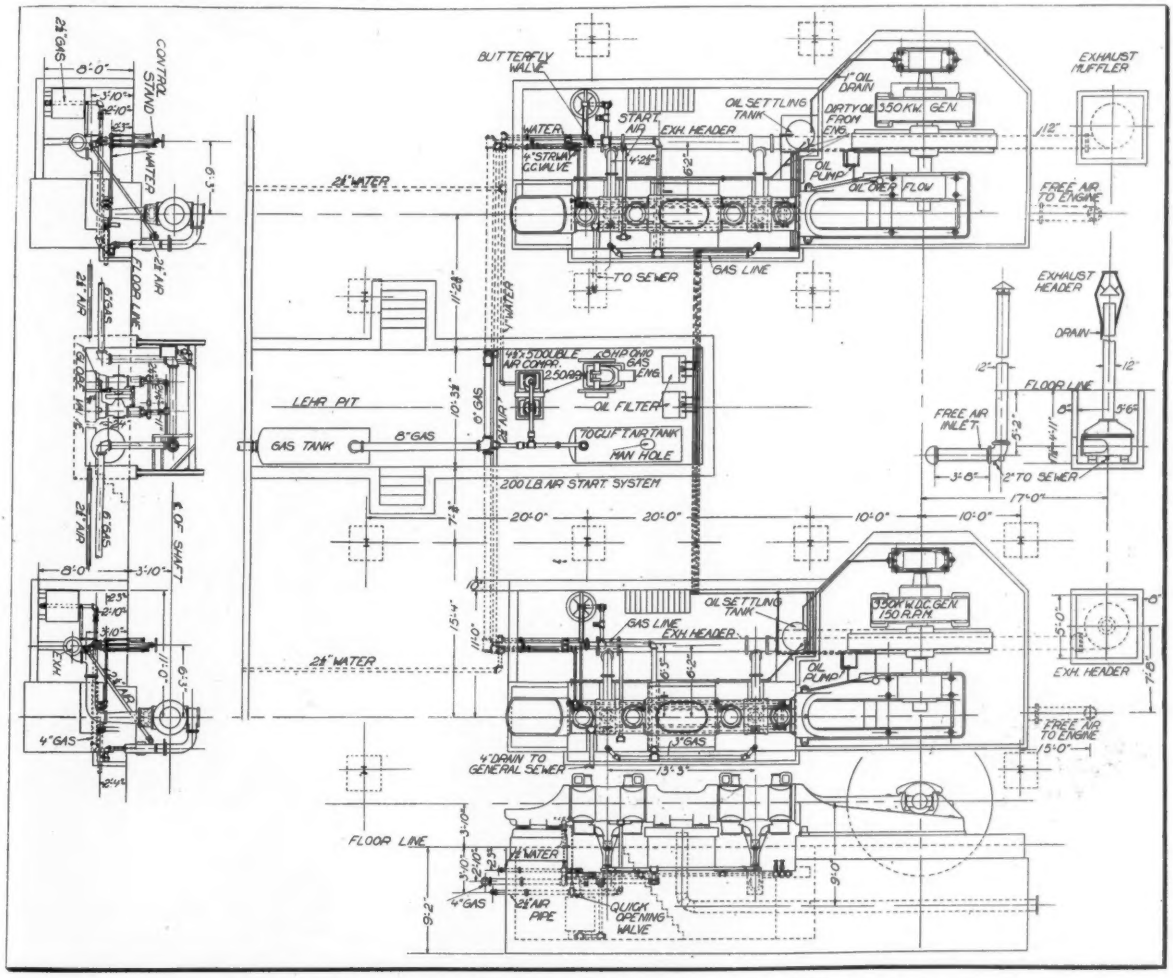


FIG. 1. PLAN AND ELEVATION OF GENERATING UNITS AND AUXILIARIES

red hot glass form and compressed air forces the glass to take the shape of the mold. As soon as the glass has set it is delivered to a conveying system, which carries the bottles to the lehrs.

To this machine there are 3 systems of air piping; a vacuum of 26 in. is carried to draw the glass into the mold, air pressure at 20 lb. is used to blow the glass to fill the mold, and an air blast at a pressure of 5 to 6 oz. is directed upon each mold to cool it to the proper temperature for handling the glass.

The capacity of each machine, of which there are six, varies from 10 to 60 bottles a minute, depending upon the size of bottles, ½ pt. to 1 gal. The speed of the machine is controlled by variable speed motors. In the process of bottle making one of the difficulties has been to proportion the ingredients so that the glass will stay hot long enough for the bottle to be made before the glass sets, which requires the use of expensive materials. With the Owens machine, however, the bottle is made so rapidly that artificial means for cooling the molds are necessary, and for this reason a more perfect bottle can be made.

From the machine the bottles go to the lehr. This is a long, hall-like oven, built of brick with fire brick lining and its purpose is to anneal the glass and thus

are provided for each furnace. These are in reality part of the bottle making machines and are kept in operation continuously for the life of the furnace, which varies from 12 to 30 months.

Beside the mass of molten glass revolves the Owens bottle-making machine, and a wonderful human-like machine it is. With unerring exactness each arm passes over the caldron, dips down to the surface of the glass, sucks an exact amount of glass into the first or forming mold and as it rises a knife passes under the mold and cuts off the glass. This mold gives the glass a general shape and cools it to a point where it does not run, then withdraws and the finishing mold closes around the still

perfect the quality of the bottle. The temperature at the end where the bottles enter is maintained at 1000 to 1200 deg. F., and gradually decreases until it reaches room temperature at the delivery end, being regulated by means of dampers and openings in the top of the lehr.

The bottles are carried through the lehr in holders, which extend across the width of the lehr and travel at the rate of about 15 ft. an hour. At the delivery end inspectors take the bottles from the holders, give them a thorough inspection, and pack them in boxes for shipment; industrial electric trucks carry the boxes to storage or the cars. Defective bottles are thrown into a chute onto an iron grating, which breaks them, and the pieces are thus in shape to go back to the furnaces. The bottle holders are placed by the inspector upon a chain, which runs beside the lehr, and carried endwise to the front of the lehr, where they are shuttled in as required.

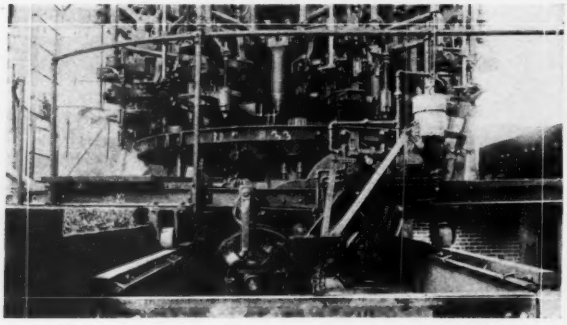


FIG. 3. LOWER PART OF BOTTLE MACHINE SHOWING LOCATION OF MOTORS

One of the chief reasons for locating the plant at Huntington is on account of the abundant supply of natural gas in the vicinity. Gas is piped to the plant at 25 lb. pressure, and for each 2 furnaces, of which there are at present 3, there is a gas house containing a meter and pressure reducer, which delivers gas at 8 oz. pressure to the burners. Under such conditions, naturally, there is no other fuel in the plant than the gas, which has a heat value averaging slightly above 1000 B.t.u. a cu. ft.

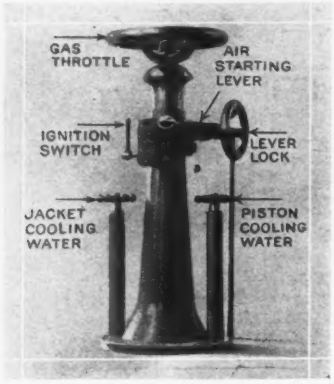


FIG. 5. CONTROLLING STAND FOR GAS ENGINE

Gas Engines

Taking up now the power plant equipment of this factory, it will be recognized that a great amount of power is required, and that absolute reliability is necessary. Wherever possible, power equipment is provided so as to keep one unit in reserve, but as an example of the demands placed on some of the motors, we would state that those running the revolving furnaces are expected to run continuously the entire life of the furnace, ranging from 12 to 30 months.

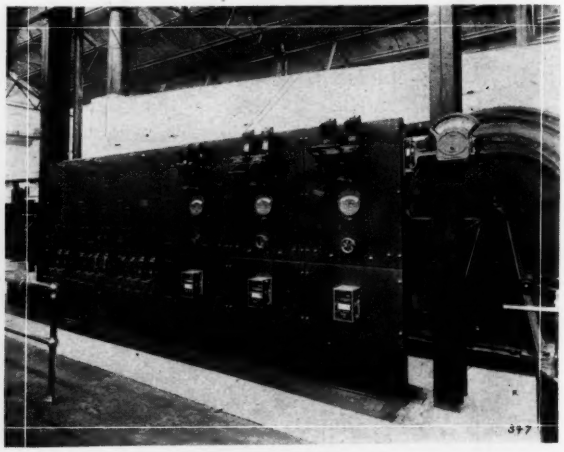


FIG. 8. MAIN SWITCHBOARD

Reference to the general plan of the plant will show the arrangement of the apparatus, and it will be noted that the space available between the lehrs is used for power apparatus Between the furnace compartment and the lehrs is a gallery, 11½ ft. above the main floor, from which the superintendent can see the working of the entire plant. This gallery extends the length of the plant and beneath it is the main pipe tunnel, from which branches run to the various machines.

Each of the 2 generating units occupies an aisle between lehrs and consists of a Cooper single tandem double acting gas engine, direct connected to a Burke generator rated at 350 kw., 250 v., d.c. The gas engines have cylinders 21½ by 36 in., and are rated at 600 hp.,

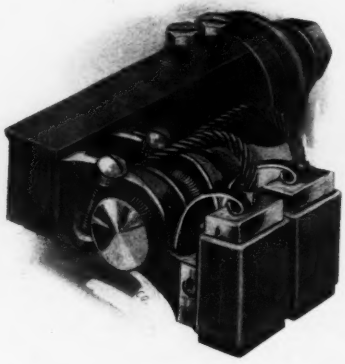


FIG. 6. TYPE OF BRUSH HOLDERS EMPLOYED ON GENERATORS AND MOTORS

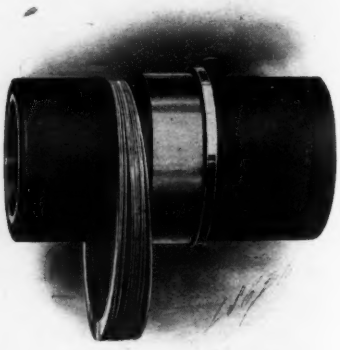


FIG. 7. BEARING WITH RING OILERS

running at a speed of 150 r.p.m. The flywheel is 13 ft. in diameter and weighs 17½ tons.

To start the main engines, compressed air is used at a pressure of 200 lb.; this cranks the engine and, after a few revolutions, it is automatically replaced by the explosive mixture when regular ignition begins in the cylinder.

To supply this compressed air, an Ohio gas engine of 8 hp. drives an Ingersoll-Rand 4½ by 5-in. compressor at 250 r.p.m. Or this compressor may be driven by an 8-hp. motor which is provided. This outfit is located in the space beneath the lehr, and when the motor is used it can be started from the main switchboard.

Speed regulation of the engine is maintained by a Jahns governor, which automatically varies the proportions of air and gas to the cylinders to meet the load requirements. This is done by imparting a rotative movement to a multiported throttling sleeve over each of the intake valves. An automatic stop is provided which shuts down the engine by tripping a switch in the ignition circuit whenever the engine speed reaches 10 per cent above normal.

Ignition of the gas is accomplished by a make and break system, and the method of driving the ignitors is such that the sparks may be timed to a small fraction of a stroke, either collectively by a single lever, or each may be adjusted independently. Each combustion chamber is provided with 2 ignitors, which work simultaneously and insure rapid ignition.

Water used for cooling the cylinder heads and piston first passes through the cylinder heads, then enters the piston rods and pistons. The higher temperature of the water thus admitted to the piston rods prevents sweating and thus insures proper lubrication. The water is admitted to each piston rod and piston from a telescopic intake pipe at the intermediate crosshead, and discharged at the main and tail guide crossheads without any reversal in the direction of flow.

A separate branch of piping leads to the cylinder jackets and separate outlets from the cylinder jackets and piston rods discharge into open funnels, so that the temperature and flow of the cooling water may be determined without difficulty.

To insure an even gas pressure at the engines, a large gas tank is provided in the line from the gas metering house to the main in the tunnel, as will be noted in the cut. The exhaust from each engine is led to a muffler, which is placed in a concrete pit, provided with a drain, outside the building, and this in turn discharges through an exhaust head. The muffler is of the centrifugal type, the gases entering at a tangent which gives them a whirl in the muffler and the discharge is from the center at the top. The muffler is so effective that the noise from the exhaust is scarcely audible a few yards away.

The entire controlling mechanism for one engine is operated from a stand and is a distinctive and convenient feature of this engine.

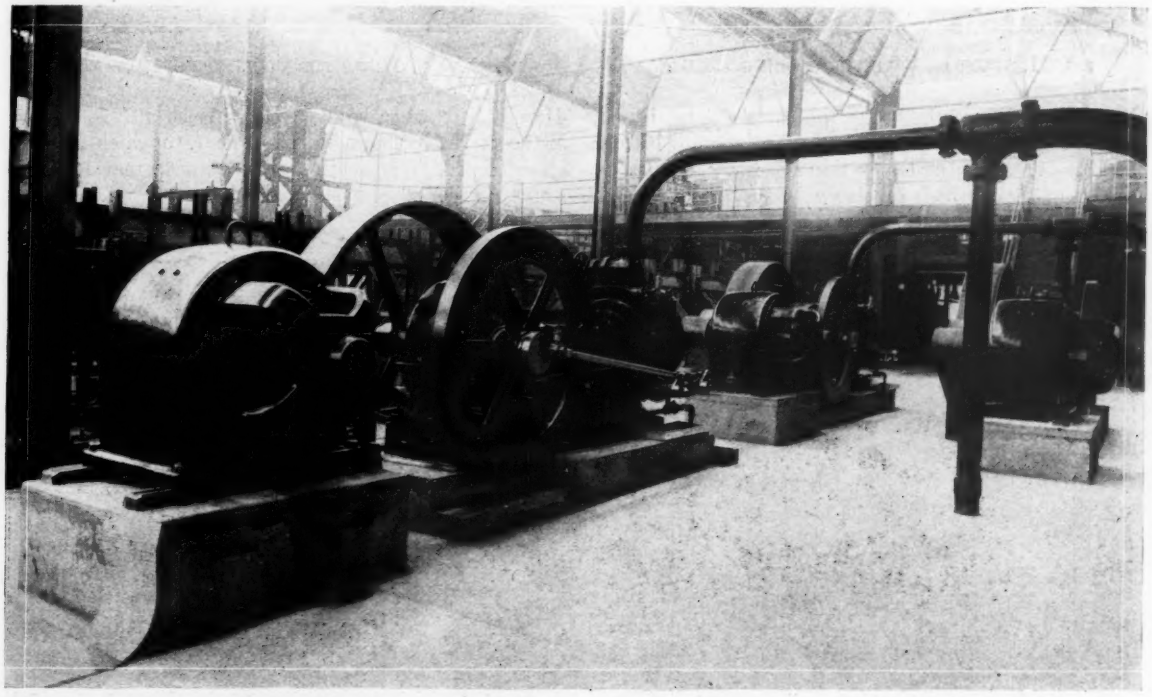


FIG. 9. ROTARY AIR COMPRESSORS, SHOWING APPLICATION OF CLOSE DRIVE

GENERATORS

DIRECT-CURRENT generators were selected for the reason that a number of the motors must run at variable speeds. The voltage carried is 250, the 2-wire system of wiring being employed, as it is less complicated than the 3-wire, and the lighting load is a small percentage of the total load on the generators. Fields of the generator are so compounded that at no load the voltage is 230, increasing to 250 at full load, and the strength of the field is so distributed that the brushes will not have to be shifted to take care of momentary overloads of 50 per cent, which the generators are designed to withstand.

A detail of design which is of interest is the brush holder, which is illustrated herewith and is used on both generators and motors; it permits the pressure of the brush upon the commutator to be adjusted evenly throughout the life of the brush, which can be used until it is almost completely gone. Another interesting feature is the ring oilers for the motor bearings; these consist of a number of disks which revolve with the shaft, spreading apart in the oil well and closing together as they go over the shaft, thus furnishing a copious supply of oil to the bearing.

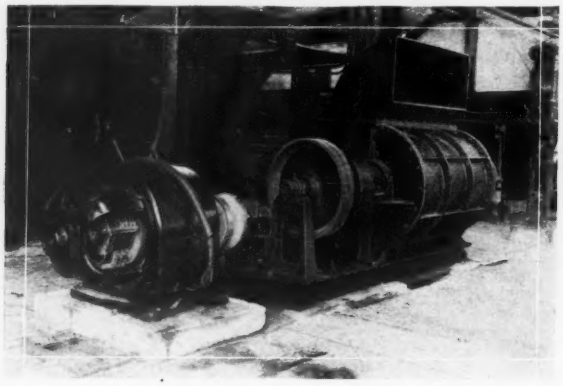


FIG. 11. BLOWER USED FOR COOLING MOLDS

The switchboard is located beside one of the generating units, attached to columns which support the roof. Cables connecting the generators to the switchboard run in specially constructed concrete tunnels, 2 ft. deep by 2 ft. wide, with 2 by 4's placed at 3-ft. intervals in the surface of both walls and floor, to which insulators are attached. The main feeder lines are carried in the tunnel under the gallery, from which all wiring to motors and the lighting system is carried in conduits.

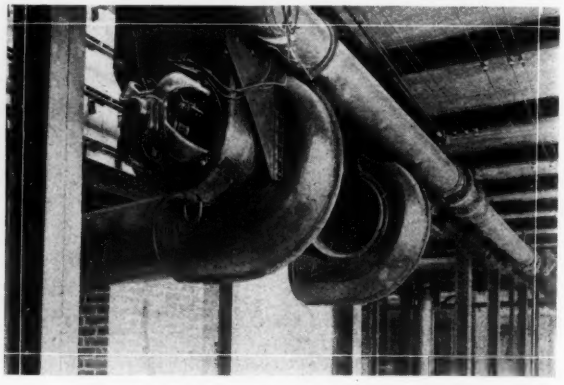


FIG. 12. BLOWERS FOR COOLING FURNACE WALLS

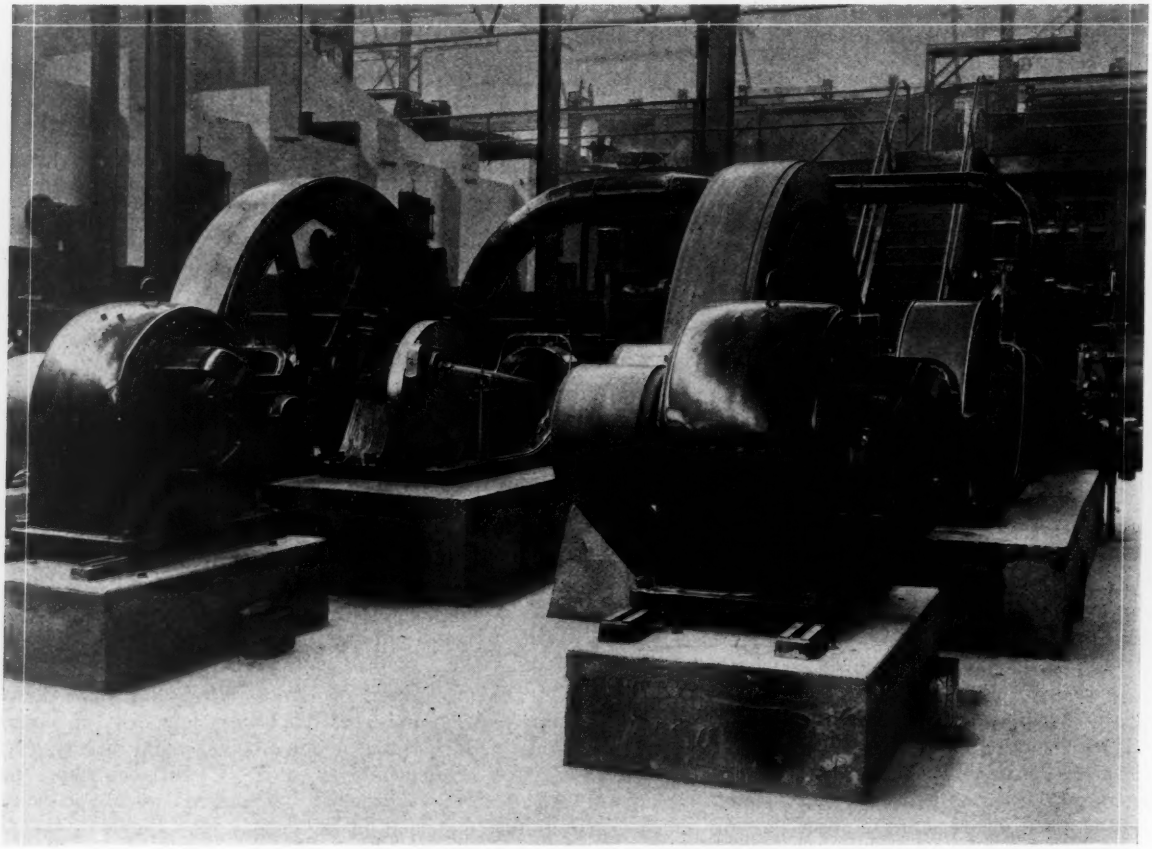


FIG. 10. MOTOR DRIVEN VACUUM PUMPS

The switchboard was designed and erected by the Underwood Electric Co., of Cincinnati, and consists of

6 slate panels, each 3 ft. wide by 6 ft. high, set 18 in. from the floor. Each generator is provided with a separate panel, next is an auxiliary service panel to control current supplied to the plant from an outside source in case it is needed, the other 3 panels control current to the various circuits. The instruments on the board consist of Roller Smith circuit breakers and wattmeters, Weston ammeters and voltmeter and Barkelew service switches.

As a protection against switchboard trouble, on each generator is a triple pole, rigid arm circuit breaker with 1 positive, 1 negative and 1 equalizer connection. The equalizer line runs from one generator to the other, while the positive and negative lines run to the circuit breakers on the switchboard. There is thus a double protection for the generators should anything short-circuit the bus bars on the main switchboard.

Air Handling Machinery

Compressed air used for blowing the bottles is supplied by 3 Laidlaw-Dunn-Gordon compressors, one of which is a standby, as 2 compressors have sufficient capacity to supply present needs of the plant. These are of the single, enclosed frame type with cylinder 18 by 12 in., and run at 150 r.p.m., giving a displacement of 525 cu. ft. a minute and delivering air at 26 lb. pressure. The driving element for each compressor is a 50-hp. Burke motor, close belted to the compressor and run at 750 r.p.m.

Vacuum for drawing the molten glass into the molds is created by 3 single cylinder Laidlaw-Dunn-Gordon rotary dry vacuum pumps, one being a standby. The cylinders of these pumps are 26 by 24 in., and they are mounted in a rolling mill frame. The speed of the pump is 100 r.p.m., giving a displacement of 1470 cu. ft. a minute and creating a vacuum of 26 in., but capable of developing 29.75 in. with a closed intake at 30 in. barometer. The motors driving these pumps are rated at 50 hp., and run at 500 r.p.m., close belted to the pump. A vacuum receiving tank is placed in the suction line to the pumps, which serves to catch oil coming from the machine and prevent it from going to the pumps.

For cooling the molds, air is furnished at 5 to 6 oz., pressure, depending upon the temperature of the atmosphere, by a No. 5½ Piqua blower connected through gearing to a 30-hp. adjustable speed interpole motor. The blower is capable of delivering air at 16 oz., but this pressure is not needed.

To cool the walls and bottoms of the furnaces, 3 No. 3½ Sirocco blowers are provided for each furnace; these are driven by direct-connected motors rated at 7 hp., running at 900 r.p.m.

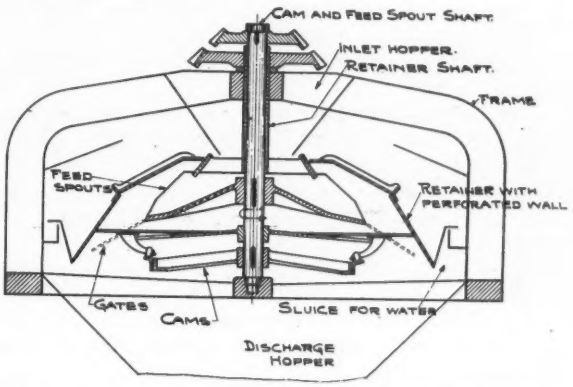


FIG. 14. CROSS SECTION OF ROTARY MIXING DRUM

Each bottle machine is run by 2 motors, one 7½ hp., of the adjustable speed commutating pole type; the other is 6 hp., series wound. These are in continuous operation except for a 12-hr. cleaning period once a week.

Steam is required in the plant for heating and cleaning purposes and is furnished by an 80-hp. Tudor marine type boiler working at a pressure of 80 lb. The fuel is natural gas and the furnace is equipped with 3 Winner burners. Water used about the factory is drawn from deep wells by 2 24 by 6-in. Cook pumps driven by 7½-hp. motors, the speed of which is regulated by a Cleveland electric controller according to the pressure in the elevated tank, which has a capacity of 40,000 gal.

In all, there are 127 motors in this plant, all manufactured by the Burke Electric Co., used as stated above and in the large machine shop which the company maintains, where many of the machines are individual drive.

Many ideas new to bottle factories have been put into effect here and the arrangement of the plant is economical of space, but provisions have been made to extend the plant almost indefinitely as demands increase.

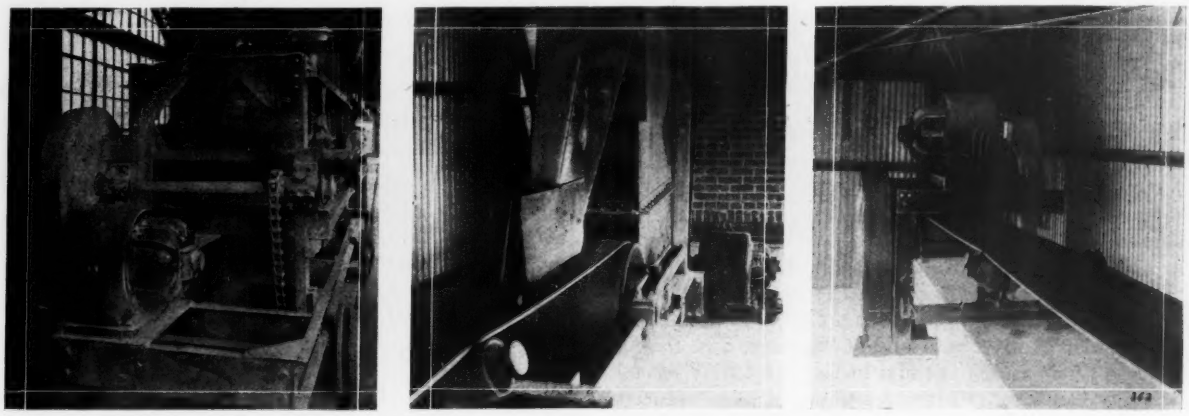


FIG. 13. MOTOR APPLICATIONS. AT THE LEFT, TRAVELING MIXER; CENTER, TOP OF 36-FT. BUCKET ELEVATOR; RIGHT, DRIVING END OF 340-FT. BELT CONVEYOR

Tests of Vacuum Pumps

Relative Value of Single and Two-Stage Vacuum Pumps. By Percy Q. Williams

THE tests herein reported have been made to determine the type of vacuum pump best suited for service in connection with Owens bottle machines. In outlining and conducting test, the following facts have been kept in mind:

It will be understood that the function of the vacuum pump is to exhaust air from the cavity forming the blank mold of the bottle machine, and in so doing, to enable the atmospheric pressure to force melted glass into the blank mold. Such air as finds its way into the system by leakage must also be exhausted and expelled through the discharge of the pump. Since air is, in fact, a perfect gas, and, therefore, expands with reduction of pressure, the degree of vacuum under which the process is carried out depends only upon the relative volume which must be exhausted, and the effective displacement of the pump; or, in other words, upon the actual amount of air which the pump can handle. Therefore, of 2 pumps of exactly the same efficiency, but having different displacement, the one having the larger displacement will develop the higher vacuum; or, if the displacement is the same, the one having the greater efficiency will develop the higher vacuum. Thus, it will be seen that the question of efficiency resolves itself into one of capacity, and that in order to carry a high vacuum in bottle machine service, it is only necessary to provide a pump of large capacity. The machine which will provide the largest actual capacity at the smallest initial expense, which will have the fewest parts to maintain and which will be the simplest to operate, will, of course, be best fitted for this service.

TABLE I. TESTS OF VACUUM PUMPS WITH CLOSED SUCTION

No. of Pump	Speed R. P. M.	Vacuum on Closed Suction	Barometer	Absolute Pressure
22681	74	29.50	29.63	.13
22681	50	29.38	29.63	.25
22681	33	29.31	29.63	.32
22680	83	29.50	29.63	.13
22680	58	29.44	29.63	.19
22680	28	29.25	29.63	.38
22680	50	29.44	29.63	.19

BAROMETER READING AFTER TESTS - 29.64

Method of Test

In order to demonstrate by actual trial, the relative efficiency of single and 2-stage pumps, the discharge pipe of one Laidlaw-Dunn-Gordon single rotative dry vacuum pump was connected to the suction of another rotative dry vacuum pump, of exactly the same size and design. By this arrangement, it was possible to operate the 2 pumps 2-stage. The fact that the vacuum cylinders were operated by separate engines, made it possible to secure any ratio of high pressure to low pressure cylinder volume.

Two series of tests were made. The first series involved 2-stage operation, at 3-cylinder ratios, or, in other words, at 3 different speeds of the high pressure pump, the speed of the low pressure pump remaining constant. In fixing the speed of the latter, it was found advisable to set the speed to correspond to that normally used, with the given number of bottle machines in operation. Single stage tests were made at various speeds, ranging from 270 ft. per min., to 402 ft. per min., either 1 or 2 machines being operated.

Throughout all of the tests, no change was made in either the speed of the bottle machine, or the kind and size of bottle manufactured.

TABLE II. RUNNING LOG OF SINGLE-STAGE TEST

Test Number	Time	Card Number	Vacuum in Line	Barometer	Temperature Degrees F.		Speed R.P.M.		M. E. P.	
					Cooling Water	Suction Air	Pump No. 1	Pump No. 2	Pump No. 1	Pump No. 2
4	3:00	19	26.875	29.23	42	60.5	67	0	30.9	
4	3:10	20	26.875	29.23	42	60.5	70	0	30.5	
4	3:20	21	26.875	29.23	42	60.5	67	0	30.6	
4	3:30	22	26.750	29.23	42	61.00	66	0	30.4	
5	3:40	23	27.062	29.23	42	61.0	80	0	29.2	
6	3:45	24	27.250	29.23	42	61.0	88	0	29.2	
7	3:50	25	27.500	29.23	42	61.0	99	0	27.5	
8	10:05	31	27.875	29.17	42	56.5	63	67	25.53	22.36
8	10:10	32	27.875	29.17	42	56.5	63	67	27.27	22.29
9	10:20	33	27.375	29.17	42	56.5	67	35	28.41	21.81
9	10:30	34	27.500	29.17	42	56.5	67	34	28.47	22.77
10	10:35	35	26.875	29.17	42	56.5	41	32	30.96	24.15
10	10:40	36	26.875	29.17	42	56.5	41	32	30.39	24.70
11	10:45	37	26.875	29.17	42	56.5	70	0	31.68	
11	10:50	38	26.875	29.17	42	56.5	70	0	30.72	

Four bottle machines were in service, operating under the following conditions:

No. 1—19 32-oz. Brandy bottles per minute.
No. 2—24 16-oz. Flasks per minute.
No. 3—36 8-oz. Flasks per minute.
No. 4—17 16-oz. Flasks per minute.

Summary of Observed and Derived Results

Before commencing any of the tests, a trial was made with both vacuum pumps, to determine the vacuum which could be developed on a closed suction. The results obtained are given in Table No. 1. It will be observed that each machine when operating at a speed of from 74 to 83 r.p.m., developed a vacuum of 29.5 in. of mercury, with the barometer at 29.63 in. This corresponds to an absolute pressure of 0.13 in. of mercury, or a vacuum of 29.87 in., referred to a standard barometer of 30 in. This value not only sets the limit at which these pumps can work, but also sets an exact measure of the volumetric efficiency, or in other words, the actual capacity which they can develop when working at any degree of vacuum less than 29.87 in.

Tables No. 2 and No. 3 comprise the running logs for the single stage and the 2-stage tests, respectively. A summary of these results and others derived from them, is given in Tables 4 and 5. The former gives the results of the single-stage test, and the latter the 2-stage test. The several items given in these summaries are self-explanatory. The relationship, however, which they show, is plotted graphically in Figs. 1, 2 and 3.

In Fig. 1, the vacuum developed in inches of mercury and referred to a 30-in. barometer, is plotted against the ratio of the high pressure to the low pressure cylinder volume. All tests shown on this curve correspond approximately to 1000 cu. ft. displacement. The point plotted at zero ratio, of course, represents a single-stage machine, since under these conditions, the volume of the high pressure cylinder becomes zero. The point plotted at unity ratio (1) represents tests with the high pressure and low pressure cylinder operated at the same speed, and consequently the same displacement. The principal point of interest shown by this diagram, is the exceedingly small increment in vacuum obtainable by 2-staging a cylinder of the particular type under test. It shows that with a ratio of high pressure to low pressure cylinder volume of 1, it is possible to develop a vacuum less than ⅛ in. in excess of that obtainable with a single-stage pump, the number of bottle machines, the number of bottles per minute and the displacement of the vacuum cylinder, remaining unchanged. For cylinder ratios between the limits given, the increment in vacuum is correspondingly smaller.

Figure 2 shows the vacuum in inches of mercury, when referred to a 30-in. barometer, developed for various displacements of the vacuum pump. All the points plotted represent single-stage tests. If it is remembered that in all cases the speed and other conditions of operation of the bottle machines remained constant, it will be seen that the vacuum carried in the line is in direct proportion to the displacement of the vacuum pump, and although the tests made cover a range from 27½ in. to 28¾ in. only, the fact that the points plotted lie almost exactly in a straight line, clearly indicates that this relationship holds good through the entire range of operation of the vacuum pump, up to its limit; that is, 29.87 in.

A comparison of the relative horsepower required to maintain a given vacuum in the line, the conditions of operation of the bottle machines remaining constant, is shown, in Fig. 3. It will be observed that points plotted on this curve are designated as follows:

An open circle—single-stage, 1 pump.

Closed circle—single-stage, 2 pumps.

A cross—2-stage.

It will be seen that for the single-stage pump the horsepower required varies directly with the vacuum developed, the conditions of operation of the bottle machines remaining constant. Apparently this relationship is independent of the number of vacuum pumps in operation. In view of the fact that tests with the 2-stage combination were made only at one displacement, it is impossible to show any relationship for various amounts of vacuum, except insofar as the vacuum developed varies with the cylinder ratio. The results as plotted, however, clearly show that no matter what the cylinder ratio is, the horsepower required to develop a given vacuum does not differ greatly in the 2 styles of pumps. When the ratio of the high pressure to the low pressure cylinder is unity (1) or in other words, when the 2 pumps are operated at the same speed, the horsepower is slightly greater in the case of the 2-stage pump. When this ratio is considerably smaller, or in other words, when the volume of the high pressure cylinder is smaller, the horsepower required is slightly less in the case of the 2-stage pump.

TABLE III. RUNNING LOG OF TWO-STAGE TEST

Test Number	Time	Card Number	Vacuum in Line	Vacuum at H.P. Suction	Barometer	Temperature Degrees F. Cooling Water	Temperature Degrees F. L.P. Suction Air	Temperature Degrees F. H.P. Suction Air	Speed R.P.M. L.P. Pump #1.	Speed R.P.M. H.P. Pump #2.	H. P. Pump No. 1.	H. P. Pump No. 2.
1	11:10	1	27.000	23.000	29.30	42			67	34	15.66	33.10
1	11:20	2	27.125	23.625	29.30	42	64	60	71	34	14.10	33.10
1	11:30	3	27.125	23.625	29.30	42	64.5	60	67	34	13.55	33.90
1	11:40	4	27.000	23.750	29.30	42	64.5	60	67	36	13.20	31.80
1	11:50	5	26.875	23.500	29.30	42	64.5	60	67	34	13.45	31.90
1	11:00	6	27.125	23.750	29.30	42	65	60	68	34	13.65	31.50
1	11.10	7	27.250	23.750	29.30	42	65	60	69	34	13.00	31.80
2	1:00	8	27.000	26.250	29.27	42	55	61	67	66	9.68	25.92
2	1:10	9	27.125	26.250	29.27	42	55	61	67	66	9.14	28.32
2	1:20	10	27.000	26.125	29.27	42	64.5	61	67	67	9.44	27.84
2	1:30	11	27.125	26.125	29.27	42	64	60.5	67	67	9.74	27.24
2	1:40	12	27.000	26.375	29.25	42	63.5	61	66	66	9.76	26.34
2	1:50	13	27.000	26.250	29.25	42	63.5	61	67	67	9.66	26.64
2	2:00	14	27.000	26.125	29.25	42	63.5	61	67	67	9.24	27.84
3	2.10	15	26.875	22.000	29.23	42	63.5	61	66	26	14.50	33.20
3	2:20	16	27.000	22.500	29.23	42	64	61	67	27	14.60	33.20
3	2:30	17	27.000	22.125	29.23	42	64.5	61	67	26	14.75	33.30
3	2:40	18	27.000	22.000	29.23	42	64.5	61	70	27	14.75	33.80

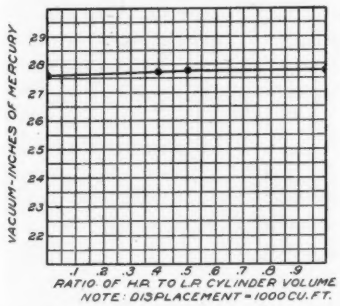


FIG. 1. RELATION BETWEEN VACUUM IN INCHES OF MERCURY AND THE RATIO OF HIGH PRESSURE TO LOW PRESSURE CYLINDER VOLUME

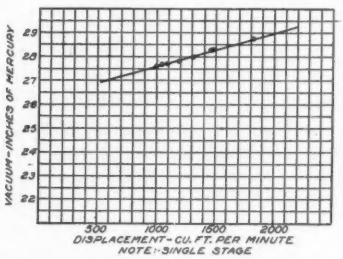


FIG. 2. RELATION BETWEEN VACUUM AND DISPLACEMENT, SINGLE STAGE

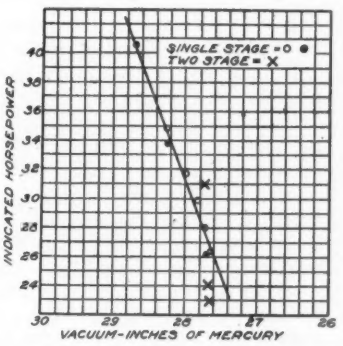


FIG. 3. RELATION BETWEEN HORSEPOWER AND VACUUM

In view of the fact, however, that the only excuse for 2-staging is to enable the pump to develop a higher vacuum, and further, since high vacuum in a 2-stage pump can only be developed when there is but a small difference in volume between the high and low pressure cylinder, it becomes evident that there is practically no advantage to be gained one way or the other by 2-staging.

Conclusions

The results of the test would seem to justify the following conclusions:

1. The advantage to be gained by 2-staging a cylinder known as the Cincinnati Gear, is so slight as to be almost negligible. Under the conditions of the test, as made, the greatest difference shown was less than ⅛ in.

TABLE IV. SUMMARY OF RESULTS OBTAINED DURING SINGLE-STAGE TEST

1. Number of test	4	5	6	7	8	9	10	11
2. Speed of pump No.1, R.P.M.	67.5	80	88	99	63	67	41	70
3. Speed of pump No.2, R.P.M.	---	---	---	---	67	335	32	---
4. Displacement, cubic feet	995	1180	1300	1460	1920	1460	1060	1029
5. Barometer, inches	29.23	29.23	29.23	29.23	29.17	29.17	29.17	29.17
6. Vacuum in line, inches	26.85	27.06	27.25	27.50	27.68	27.44	26.88	26.26
7. Abs. pres. in line, in.	2.38	2.17	1.98	1.73	1.29	1.73	2.29	2.29
8. Vacuum in line referred to 30" Bar. inches	27.62	27.83	28.02	28.27	28.71	28.27	27.71	27.71
9. Temp. of cooling water	42	42	42	42	42	42	42	42
10. Temp. of suction air	60.5	61	61	61	56	56	56	56
11. Horsepower pump No.1.	26.45	29.90	31.70	34.61	21.30	24.20	16.10	28.00
12. Horsepower pump No.2.	-----	-----	-----	-----	19.15	9.56	10.00	-----
13. Total horsepower	26.45	29.90	31.70	34.61	40.45	33.76	26.10	28.00

2. In order to secure an increment in vacuum with a single-stage pump, equal to that obtainable by 2-staging, it is only necessary to increase the speed of the single-stage pump less than 10 per cent.

3. The vacuum developed with a single-stage pump varies directly as the displacement of the pump. In other words, equal increments of speed correspond to equal increments of vacuum.

TABLE V. SUMMARY OF RESULTS OBTAINED DURING TWO-STAGE TEST

1. Number of test	3	1	2
2. Speed of low pressure pump, R.P.M.	67.5	68	66.9
3. Speed of high pressure pump, R.P.M.	26.5	34.3	66.6
4. Cylinder ratio	2.55	1.98	1.00
5. Displacement, cubic feet	995	1000	990
6. Barometer, inches	29.23	29.30	29.26
7. Vacuum in high pressure suction, inches	22.19	23.62	26.21
8. Vacuum in line, inches	26.97	27.06	27.03
9. Absolute pressure in line, inches	2.26	2.25	2.23
10. Vacuum in line referred to 30" barometer	27.74	27.75	27.77
11. Temperature of cooling water, Degrees F.	42	42	42
12. Temperature of low pressure suction, Degrees F.	61	60	61
13. Temperature of high pressure suction, Degrees F.	64.5	64.6	63.5
14. Horsepower, low pressure cylinder	12.65	8.28	7.90
15. Horsepower, high pressure cylinder	11.30	14.36	23.10
16. Total horsepower	23.95	22.65	31.00

4. The horsepower requirements for a given amount of vacuum, under any particular condition of service, are not materially different for the 2 types of pumps. With a high cylinder ratio, a slight advantage lies with the 2-stage. For a low cylinder ratio, the advantage lies with the single-stage.

5. The conclusions already reached as to horsepower, are confirmed by the fact that with the highest cylinder ratio used, there is but 5 deg. increase in temperature of the suction air to the high pressure cylinder, over that to the low pressure cylinder.

Boiler Code Completed

Final Adoption of Standard Rules by Council of A. S. M. E.

A SIGNAL event for the boiler industry and one that means much to the field of power production in general, was the completion of the report of the Committee to Formulate Standard Specifications for the Construction of Steam Boiler and Other Pressure Vessels and for Care of Same in Service, and its presentation to the Council of the American Society of Mechanical Engineers, on Feb. 13, 1915. The benefits that will accrue from an economical standpoint, when the rules for construction embodied in the new code are generally put into effect, are far-reaching, and will affect alike the manufacturer and the user of boilers.

The work involved in the final revision of the Code was one of the most strenuous and trying committee undertakings ever carried out in the history of the Society, covering a period of nearly 8 weeks. The Boiler Code Committee worked constantly in conference with the Advisory Committee which had been appointed in December and the sessions which were both investigative and judicial in character, were marked by intense interest of the committee members, the daily sessions lasting usually throughout the day and until midnight. A notable feature of the final revision was the amount of research work involved, several series of tests having been carried out by members of the committee to check and establish the authenticity of the rules and formulae embodied in the Code.

The work of the Committee was confined to rules for construction of steam boilers only, all references to "other pressure vessels" and to laws and matters of legislation having been omitted. The result of the work of revision of the construction rules was the division into 2 parts, one for new installations and the other for existing installations, and following this was provided an appendix in which were placed the rules, examples, illustrations, references, and data that were in nature supplementary to the rules. As now laid out, the rules for new installations (Part 1) cover all details of construction of new steam boilers and the rules for allowable working pressures upon them, the details being referred to in the following order: Materials of construction, including the material specifications, maximum allowable working pressures, boiler joints, braced and stayed surfaces, combustion chambers, tubes, riveting and calking, manholes and handholes, safety valves, water and steam gages, and fittings and appliances. At the end of Part I is a section devoted to heating boilers, in which the above order of subjects is also adhered to. In Part II, which is devoted to existing installations, the same order of subjects is followed, although less complete and exacting in details. The Code is now being issued in pamphlet form at 40c per copy to members and 80c to non-members.

It is pleasing to find that the Code is finding immediate application. The State of Indiana is at this time considering the matter and it is probable that an amendment will be passed by the legislature rendering the former Indiana boiler code optional, with the proviso that the A. S. M. E. Code may be used for boiler construction in place of the present State code if desired. The Ohio State Boiler Board has the new Code under consideration and it is possible that it will be adopted in place of the boiler code now in force in that state. In Wisconsin the Code will probably take immediate effect as a result of an action of the Industrial Commission of Wisconsin taken last year looking forward to the A. S. M. E. Code before it was completed; while a preliminary set of boiler rules were put into effect in that state the first of this year, provision was made for their replacement by the A. S. M. E. Code as soon as finished.

When the Air Pump Failed

By J. C. Lee

THEY had taken it apart and put it back, and then had done the job over again, still it didn't work so down it came again.

The foreman, who was a first-class mechanic, couldn't find the trouble; neither did any of the engineers. Meanwhile, the dust accumulated in the machines, causing more or less trouble, as this was a lighting plant and the regular blowing out of the machines was important.

When it was finally discovered that the long, slender rod working inside the piston rod should be in one piece instead of two, the cause of failure was found.

Simply a broken reversing rod was the cause of failure of the 9½-in. Westinghouse pump. The best remedy is a new one, as they are hard to repair, and their cost is not high.

In this case, the men working on the pump were good mechanics; but, as the pump had never given any trouble beyond occasional packing of the piston rod no one had paid much attention to it. No piece of machinery is more reliable than one of these pumps. They, however, like any other machine, are at their best when kept clean, at least as to the inside; the outside makes little difference, except at the strainer where the air enters.

To clean an air pump, a good plan is to disconnect the discharge pipe from air line or reservoir; then remove strainer, putting in a pipe on suction side. Pump a strong solution of soda ash or lye through, letting it discharge into a tub or barrel, so it can be pumped through again if necessary. After the air end is cleaned, pump clean hot water through, then removing any acids or alkalis, which would ruin the gaskets in pipe fittings, or the air hose.

Many engineers use entirely too much oil in the air cylinder, thus reducing the efficiency of the pump; as the ports become gummed up and dirty, the lift of the valves is reduced and friction of the machine increased. Often, instead of using the oil cup provided for the purpose, oil is admitted through strainer; this should never be done.

If necessary to oil while running, open the cup, and as piston descends, oil will be drawn in.

These pumps are provided with governors which shut off the steam when air pressure reaches a desired point. The governor is regulated by turning a nut which acts on a spring, increasing or decreasing pressure as desired.

If the governor fails to operate the pumps properly, look for the following troubles: Steam valve held open by foreign substance between valve and seat; leaking pin valve; drip pipe stopped up; or governor piston may be stuck.

Start the air pump slowly, as no provision for cushioning is made in the steam end and until some air pressure is pumped up to cushion the piston, it may strike heads.

Overheating of pump can be caused by any of the following: Running too fast; air inlets and passages gummed up; worn piston rings; allowing air to pass piston; or pumping against high pressure. However, as 50 to 75 lb. is often enough in plants, this last cause will hardly ever be found.

Annual Cost of Coal

IN making an estimate of the cost of coal which a plant will consume for an entire year, as well as the saving in cost of fuel by a reduction in steam consumption per kilowatt-hour, the chart given in the Practical Reference Tables of this issue will be found convenient.

To use this chart the load factor must be quite definitely known and may be found by dividing the total kilowatt-hours generated during a year by the product of the total capacity of the plant multiplied by 24 and by 365. Then from the value of the load factor, found as above, at the upper lefthand side of the chart, trace to the right to the diagonal line showing the cost of the coal in dollars per long ton; then trace vertically downward to the diagonal line representing the pounds of water evaporated per pound of coal; then trace to the left to the scale. The value found here multiplied by the total capacity of the plant in kilowatts and by the pounds of steam consumed per kilowatt-hour will give the annual cost of coal.

When making a change in equipment the annual saving in cost of coal may be found by multiplying the value found in the scale at the lower lefthand side by the capacity of the plant and by the pounds of steam saved per kilowatt-hour by the new equipment.

To illustrate: Assume a plant of 1000 kw. capacity which has a yearly load factor of 0.6, coal costs $3 a long ton, the amount of water evaporated per pound of coal as fired averages 8 lb. and the steam consumed per kilowatt-hour generated averages 30 lb.

The arrows show how the problem is traced on the chart and the figure in the cost scale is $0.90; this multiplied by 1000 and by 30 gives $27,000 as the annual cost of coal.

If, by adding a condensing system to the plant, the steam consumption per kilowatt-hour may be reduced to 28 lb., making a saving of 2 lb. per kilowatt-hour., the annual saving may be estimated as above, only multiplying the cost found on the scale by 1000 and by 2, giving $1800.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Berkshire Street Railway Portable Substation

CONVENIENT PIECE OF APPARATUS MAY BE SHIFTED ABOUT WHENEVER AND WHEREVER THE LOAD DEMANDS

THE Berkshire Street Railway Co., Pittsfield, Mass., placed in service this last summer a new semi-outdoor type of portable substation for the purpose of supplementing the power supply on certain heavily loaded sections of the road during the increased summer excursion traffic. This substation was built by the General Electric Co., and has a continuous capacity of 300 kw. at 600 v., transforming from a 33,000-v., 25-cycle, 3-phase line supply.

This substation consists of an enclosed operating compartment containing the synchronous converter, the 3-panel switchboard and the 3-unit electric heaters; an enclosed central room for the multi-gap lightning arrester equipment; and an open section for the main transformer, the current transformer, automatic oil switch, choke coils, disconnecting knife switches, etc. Owing to the low clearances of the various bridges on the lines, the car has been kept within the comparatively low height of 11 ft. 6 in. above the rails, including the running board.

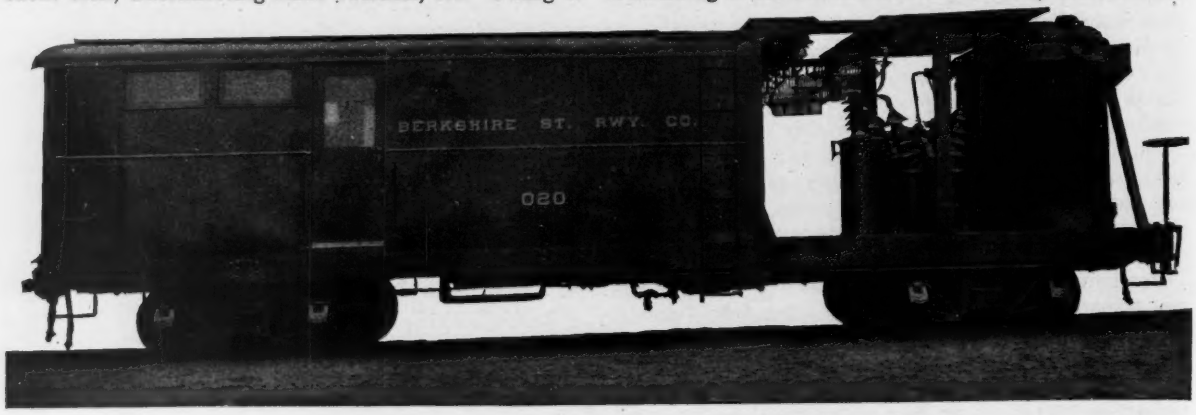


FIG. 1. PORTABLE SUBSTATION BUILT FOR BERKSHIRE STREET RAILWAY CO.

A snow shield formed of sheet steel of No. 12 B.W.G. and framed with angles, extends from the center on top of the support over to a wooden block base on the transformer top. This protects the high tension bushings to the transformer, which are brought out in a horizontal position because of lack of overhead clearance on the road, and also those to the oil switch units and the current transformer. A short cover likewise extends over the incoming line leads and those to the lightning arrester compartment at the other end of the supporting frame. The incoming insulators each side of the choke coils are suspended from cross steel angles tied into the framing.

The current transformer and the oil switch units are fastened down with the usual wooden cleats and angle lugs riveted to the floor plates. In the lightning arrester compartment, a steel angle is placed longitudinally near the top of the compartment and riveted to the partitions to anchor and support the arrester units.

The section of the roof over the converter is bolted down so that it may be readily removed for installing or dismantling the apparatus when a crane is available. A galvanized sheet metal ceiling is built on the interior so as to form air pockets between it and the roof sheathing to prevent any direct radiation of heat when the car is standing in the sun and also to drain any condensation or possible leakage to one side of the car away from the apparatus.

The car is provided with 4 doors, one on each side entering from the outside into the operating or synchronous converter apartment, one in the side of the partition connecting the operating and lightning arrester compartments, and one entering the latter compartment at the other end from the outdoor portion of the substation.

The electrical equipment includes a 3-phase, 25-cycle, 600-v., commutating-pole, synchronous converter operating at 750 r.p.m. Transformer connections are arranged for alternating current starting from 50 per cent, secondary taps, with series resistance to cut down

the initial rush of current. The machine has a normal rating of 300 kw. continuously, 450 kw. for 2 hr. and a momentary overload capacity of 900 kw. This high overload capacity is considered a very important feature for interurban railway substations.

Temperature guarantees and insulation tests follow the recommendations of the A. I. E. E.; as follows, full load temperature rise 24 hr., 35 deg. C.; 150 per cent load temperature rise 2 hr., 55 deg. C.; high potential test, armature, 2000 v.; high potential test, shunt fields, 5000 v. The series field is designed to give practically flat compounding at all loads without shunt field adjustment.

The machine is equipped with speed limiting device, mechanical end play device, field breakup switch, equalizer switch, 1000 amp. negative line switch, field rheostat, back-of-board type starting resistance, and leveling device. The usual brush-raising device is also supplied for use in connection with alternating current starting.

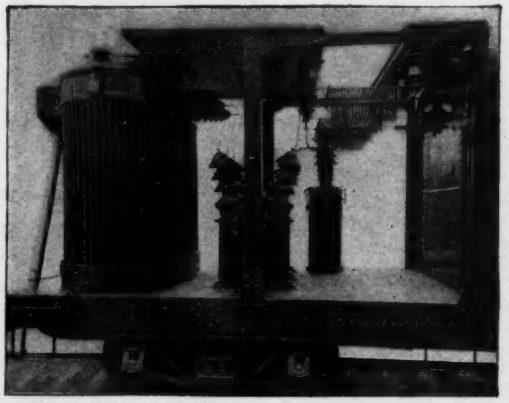


FIG. 2. OUTDOOR SECTION AND APPARATUS OF SUBSTATION

The equalizer and negative line switches are mounted on the outer pillow block. An opening is provided in the floor for connecting the equalizer to a stationary substation if parallel operation is desired.

The transformer is an oil-insulated, self-cooled, outdoor type, rated 330 kv.-a., 3-phase, 25 cycles. Voltage taps are arranged on the primary, or high tension side for unusual flexibility, operating at either 33,000, 13,000 or 11,000 v. Y by using either series or multiple connections of the primary coils. The secondary, or low tension winding, is designed for 385 v. and is provided with the 50 per cent starting taps previously mentioned. Series resistance is also used in starting. In order to make the secondary leads weather-proof at the point of entrance, they are enclosed in a small sheet iron box, from which the connections are carried to the switch panels through conduit. The transformer is designed with high inherent reactance to give practically flat compounding on the d.c. side of the converter, and is rated in accordance with A. I. E. E. recommendations, the allowable temperature rise after 24 hr. operation at full load being 35 deg. C. After 2 hr. operation at 150 per cent load, the temperature rise will not exceed 55 deg. C. Three times normal load on the converter, or 900 kw., can be carried momentarily. The high potential insulation test required was: high tension winding, 66,000 v.; low tension winding, 2000 v.

The current transformer for the automatic tripping device is a 15-30 amp. special outdoor type, and is installed in the outdoor section directly back of one of the oil switch units and connected to the high tension circuit.

The automatic oil switch is a 300-amp., 45,000-v., triple-pole, single-throw, outdoor type. The series transformers and tripping device are self-contained. The operating mechanism is entirely enclosed and the units are fitted with outdoor bushings, thus being adequately protected from exposure to the weather. The switch is provided with bell alarm to notify the attendant when the switch opens. This oil switch trip is instantaneous in action so as to afford complete protection to the machines and feeders under short circuit conditions.

FIG. 3. 300-KW., 600-V. COMMUTATING-POLE SYNCHRONOUS CONVERTER

An alternating-current arrester of the standard multigap type, consisting of a series of spark gaps shunted by graded resistances but without series resistance, is employed. It may be connected for protection of either the 33,000-v. circuits or the 13,000 and 11,000-v. high tension supply.

The 3 33,000-v., 300-amp. disconnecting switches are of the single-pole, single-throw, outdoor type. They are installed immediately under the high tension entrance opening and are connected in the main line circuit, so that they cut out all the apparatus in the station, including the lightning arrester. If it is necessary to make any adjustments on the lightning arrester, the line circuit will be opened and the lightning arrester circuit disconnected by hand. An 8-ft. switch hook is furnished for manual operation of the switches.

Three 200-amp. choke coils of the cylindrical, outdoor, suspension type are used and are supported in a horizontal position by the disconnecting switches at one end and by insulators at the other. The direct-current lightning arrester for the 600-v., direct-current feeder

circuit is the aluminum cell type and is mounted inside the car back of the direct-current switchboard panel.

A transformer panel, direct-current feeder panel and alternating-current starting panel compose the 3-panel switchboard.

All panels are of natural black slate and are mounted on pipe framework. The transformer panel is 48 by 20 in., and the feeder and starting panels are each 48 by 16 in. All 3 panels have 20-in. subbases. The instruments are all a dull black finish to match the panels.

The equipment installed on the transformer panel consists of one 1500-amp. ammeter with shunt; 750-v. voltmeter; 385-v., 5-amp. wattless component indicator with 300-0-300-kw. scale; operating lever for the automatic oil switch; 2 2-point potential receptacles, and one 2-point plug and holder.

FIG. 4. SWITCHBOARD IN SUBSTATION

The direct-current feeder panel is equipped with one single-pole, 600-v., 1000-amp., carbon break circuit breaker, hand operated, with low voltage release and bell alarm switch; handwheel with mounting and field rheostat; single-pole, single-throw, 600-v., 1000-amp. lever line switch; and a 600-v., 1500-amp., 2-wire recording watthour meter installed on the subbase.

On the synchronous converter starting panel are installed a double-pole, double-throw, 800-amp. synchronous converter starting switch and 2 double pole, single-throw, 250-v., 100-amp. lever switches with enclosed fuses on the front of the panel. These last-mentioned switches furnish current to the lighting and heating circuits. Card holders are mounted over the switches on all panels.

Current for lighting the 2 interior compartments and the outdoor section and for heating the operating compartment is taken from the partial voltage taps on the transformer secondaries. The heaters are fastened to the partition and side of the car at one end of the switchboard, and consist of 3 units normally rated at 900 w. each. Each unit has 2 coils, making a total of 6 coils connected in parallel with separate switches on the heater to secure a gradation of heat. All cable leads and wiring are run in iron conduit securely fastened to the car framing. Monitor entrance bushings are provided at the ends of the conduit.

The specific dimensions and important data applying to this portable substation are the following: length over all, 38 ft.; width over sides of car, 8 ft. 4 in.; maximum width, over side channels, 8 ft. 6 in.; height over all, including running board, 11 ft. 6 in.; height of floor above rails, 3 ft. 8½ in.; total length of enclosed cab, 23 ft. 6 in.; length of converter or operating room, 14 ft. 6 in.; length of lightning arrester compartment, 9 ft.; length of outdoor section, 14 ft. 6 in.; truck base, 25 ft.; wheel base, 5 ft. 2 in.; wheels, 33 in.; track gage, standard, 4 ft. 8½ in.; total weight, 80,000 lb.

Operating Costs of Gas-Filled Tungsten and Flaming Arc Lamps*

EQUIVALENT AMOUNT OF ILLUMINATION WITH LESS ENERGY CONSUMPTION AND LOWER COSTS OF REPAIRS, LABOR AND FIXED CHARGES CAUSE GAS-FILLED LAMP TO BE USED BY CITY OF CHICAGO

ABOUT 6 months ago, after a thorough investigation, the Department of Gas and Electricity of the City of Chicago decided to discontinue installing 465-w. flaming arc lamps and to install in their stead 20-amp., 300-w. gas-filled tungsten lamps. The favorable results obtained so far from the 1800 which were installed 2 months ago lead us to believe that this 300-w., 600-candle-power, gas-filled tungsten lamp, which gives an equivalent illumination to that of the 465-w. flaming arc after the flame lamp has been in service a short time, is the most economical high power open street illuminant on the market today. When the slagging of the carbons and the etching of the inner globe of the flaming arc are eliminated the arc should be a strong competitor of the gas-filled lamp.

Gas-filled lamps purchased under a guarantee of 1000 hr. life make a more flexible operating system, give a more uniform light and cost less to install and maintain under our local conditions. It is planned to replace within the next 2 yr. the 6248 7-amp. 450-w. enclosed lamps (giving only about 250 candle-power) with the 300-w., 600-candle-power gas-filled tungsten lamps, and to extend the system with 8000 additional lights of this type.

The largest saving in operating the gas-filled lamp under our local labor conditions lies in the trimming and patrolling item. This saving is brought about by allowing an average of 750 gas-filled lamps to be cleaned and patrolled by one man, who is paid, beside his salary of $100 a month, $3.75 per day for an automobile supplied by him, making a total cost for attendance of $4, as against $7.44, the cost for labor to trim flame lamps, a saving of over 45 per cent.

Although the cost for 4 gas-filled tungsten renewals a year (which the manufacturer guarantees not to exceed)

*Discussion by E. W. Tompkins at meeting of Western Society of Engineers.

is nearly 3 times the annual cost for flame arc carbons, the relative saving in such items as the cost of power and fixed charges in the gas-filled installation more than offsets this high cost for lamp renewals. It is probable that the life of these 20-amp., 300-w. nitrogen lamps will, within a short time, materially exceed the present guaranteed 1000 hr. life, which would result in a still greater saving over that of the flaming arc.

On Nov. 1, 1914, there were in service 2500 of these gas-filled lamps. Of this number, 408 located on 4 circuits have burned a total of 1003 hr. with an outage due to lamp burnouts of 15.4 per cent. This makes the total average life to date 920 hr. We are so well satisfied with this showing that we feel justified in anticipating a much longer average life than that of the 1000 hr. guaranteed.

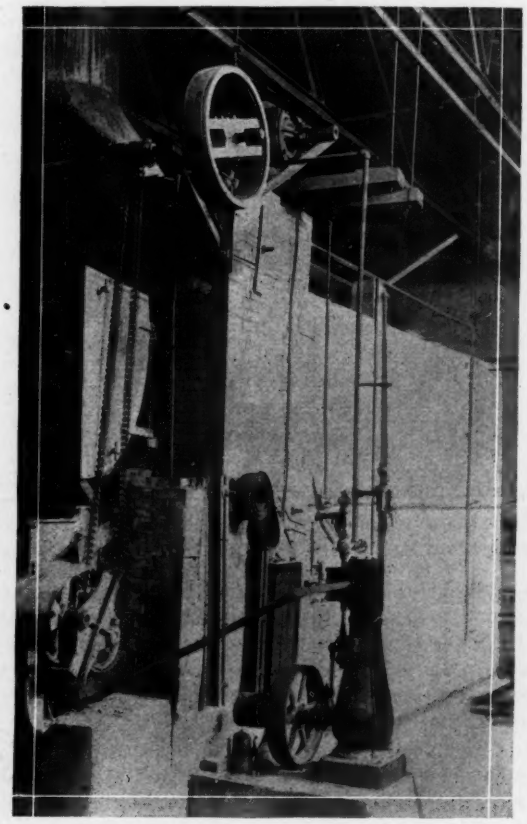


FIG. 1. MOTOR DRIVING STOKERS; RHEOSTAT ON SIDE OF BOILER

These results, coupled with the lowered cost of the lamps, due to improvements in the art of manufacture, and larger discounts based on increased annual purchases, will more than compensate for an increased cost of energy that may occur.

At present, the total annual cost to operate a 465-w. flaming lamp with energy at ½c. per kw.-hr. delivered at the circuit terminals, is $50.58, including $17.46 fixed charges, while the cost of a 300-w. gas-filled lamp (365 w. including compensator losses) is $49.43 a year, allowing $13.27 as investment charges. These costs are divided approximately as follows:

	465-W. Flame Lamp Per Cent	300-W. 600-C.P. Gas-Filled Lamp Per Cent
Energy	22.5	18.1
Carbons or renewals	11.6	32.9
Globe and lamp repairs	4.9	1.9
Trimming and patrolling	14.7	8.1
Repairs to circuits	11.8	12.1
Fixed charges	34.5	26.9
Total	100.0	100.0

An inspection of these various percentages will show that while an increase in the energy cost will materially add to the annual maintenance charge on the flame lamp, on the gas-filled lamp it will be not so marked. An increase in the cost of carbons which at present is a likely event, tends to add to the cost of the flame lamp, while the tendency is toward a reduction in price for the renewals on gas-filled lamps. The other items entering into lamp maintenance are not subject to any material change.

Motor Equipped Boiler Room

DESCRIPTION OF DRIVES IN A LOW-PRESSURE HEATING PLANT. BY C. V. HULL

IN one of the large tractor manufacturing plants, a battery of 4 16-ft. fire-tube boilers is used for heating. These boilers are equipped with automatic stokers, installed in the regular manner; but instead of being engine-driven, the stokers are operated by an electric motor.

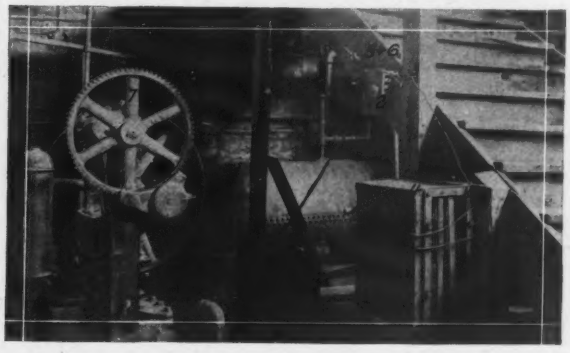


FIG. 2. MOTOR AND CONTROL FOR SUMP AND BOILER-FEED PUMPS

The speed of the motor is controlled by means of an old arc lamp rheostat, which shows on the side wall of the boiler in Fig. 1. Diagram (Fig. 3) shows the connections quite clearly, from which it will be noted that the 220-v. motor is run with 110 v. on the armature circuit.

While a steam engine is also provided, it is seldom put in service, the motor being usually used. This is possible because the tractors which are being tested in the power house, are belt connected to shunt-wound generators, run in parallel. Direct current at 230 to 250 v. is supplied to a 3-wire system for 24-hr. service.

The main feed water pump is driven by a motor which is also used to drive a centrifugal pump in the sump, though a direct-acting steam pump has been installed for emergency. It is necessary to change belts for this.

In order that the various speeds may be obtained for operating both pumps satisfactorily, 110 and 220-v. circuits are connected to the armature. The field is in circuit except when switch No. 6 (Fig. 4) is opened. This, however, is seldom done, as the double throw

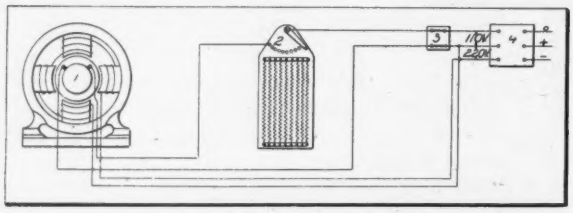


FIG. 3. WIRING DIAGRAM OF STOKER MOTOR

switch No. 3 opens either circuit, and the motor is supposed to be in operation continuously when there is a fire under the boilers. The 220-v. starting rheostat No. 2, Fig. 4, is used if it is necessary to raise the water in the boilers quickly. It is also used when pumping out the sump.

When pumping for ordinary boiler feed the armature is in series with a 220-v. variable speed rheostat, but connected to the 110-v. circuit. Figure 2 shows this clearly.

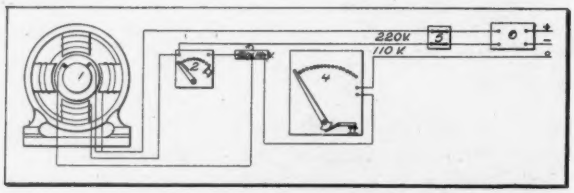


FIG. 4. WIRING DIAGRAM OF SUMP AND BOILER-FEED PUMP MOTOR

When operating, the fireman has only to change either rheostat slightly (No. 2 of Fig. 3 and No. 4 of Fig. 4) to vary the fire or change the rate of water supply. The controls are so simple that no trouble has been experienced with them. Switch No. 3 of Fig. 4 makes confusion practically impossible. The steam pump and stoker engine are used only when the power house is shut down so that no current is available.

IN ONE of the medium-sized central stations in Ohio, the operators gage the time for cleaning the turbine blades by observing the records produced by a steam-flow meter connected to the steam intake of the turbine. When the records from this flow meter and from other station instruments indicate that the 6000-kw. turbo-generator is requiring 18 lb. of steam per kilowatt-hour the operators know that conditions are just normal; but when the big machine requires 19 lb. of steam to produce 1 kw.-hr., the engineer knows that scale forming from the impure feed water has begun to coat the turbine blades and that economic operation can be obtained only after the machine has been "taken down" and cleaned.—Electrical World.

Induction Motor Slip and Slip Meters

DIFFERENCE BETWEEN ACTUAL AND SYNCHRONOUS SPEED PROPORTIONAL TO LOAD; SECTORED-DISK AND VIBRATING REED SLIP METERS

DURING one alternation of the supply current, the revolving magnetic field of an induction motor travels from one pole to the next, so that the number of revolutions per minute of the rotating field is equal to the frequency of the system divided by the number of poles of the stator winding. For instance, on ordinary 60-cycle circuits, the revolving field of a 6-pole induction motor makes 60 ÷ 6, or 10 revolutions per second, or 600 r.p.m.

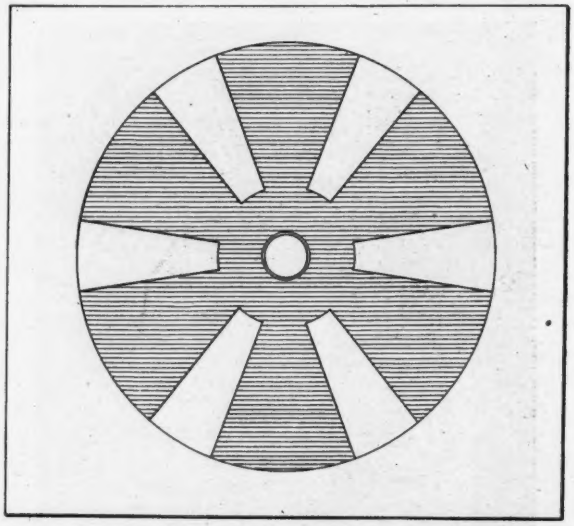


FIG. 1. SECTORED-DISK ATTACHED TO MOTOR FORMS A CONVENIENT MEANS OF MEASURING INDUCTION MOTOR SLIP

In order that the magnetic lines of force of the revolving field may cut the secondary conductors, that is, the rotor conductors, the speed of the rotor must be less than that of the revolving field. In practice, the speed of the rotor at full load is a few per cent less than that of the revolving field; as for example, the actual speed of the above-mentioned motor would be somewhere near 585 r.p.m. The difference in speed between field and rotor is referred to as the "slip" of the motor and is usually measured in per cent of the speed of the revolving field, or the "synchronous speed." Thus the synchronous speed of the motor in question is 600 r.p.m., and the slip at full load is equal to the difference between 600 and 585 divided by 600, or 2.5 per cent.

Slip depends upon the load carried by the motor and increases with it. At no load, the motor runs almost synchronously, because but a small difference of speed between the revolving field and the rotor is sufficient to induce currents in the latter, furnishing the required torque to overcome friction and windage. An increase of load results in an increase of slip with the accompanying decrease in speed and increased induced currents; in consequence, the torque in the motor is increased as it ought to be. With a continued increase of load, the

slip increases and the speed decreases up to a certain limit, at which the motor will "pull out" and come to a stop.

Measurement of Slip

Slip usually constitutes but a small per cent of the speed; but an accurate knowledge of its value is of importance, not only to the designer but also to the operator of the motor. When slip is determined as the difference between synchronous speed and actual speed, a small error in the determination of either may lead to a considerable error in the value of the slip figured out as the difference of the 2. For this reason, it is preferable to measure slip and speed directly and independently of each other and determine the frequency of the supply from the sum of the 2.

A slip meter, easily constructed by anyone, consists of a pasteboard or sheet metal disk having as many white sectors painted on it as the number of poles of the motor. This slip meter, known as the sectored-disk slip meter, is mounted on and secured to the shaft of the motor. An alternating-current arc lamp fed from the same source of supply as the motor and therefore having the same frequency, is placed before the disk. If the motor could revolve synchronously, the white sectors would appear stationary; but, as the speed of the motor is a few per cent below that of synchronism, the sectors appear to the eye slowly rotating in the direction opposite to that of the shaft.

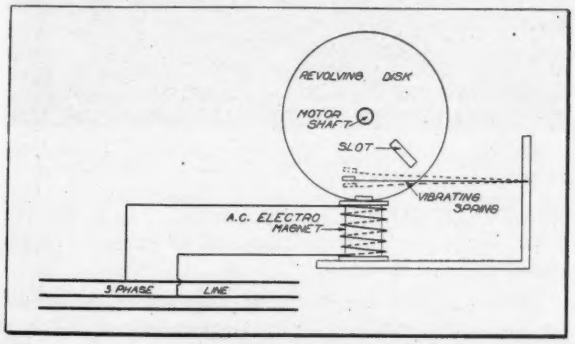


FIG. 2. GENERAL OUTLINE AND DIAGRAM OF CONNECTIONS OF VIBRATING REED SLIP-METER

This action may be explained as follows: While not apparent to the human eye, the light of the alternating-current arc lamp is extinguished once during each alternation of the current. With synchronous rotation of the disk, each sector has just enough time during one alternation to occupy the position of the preceding sector so that when the lamp relights, the eye of the observer finds the sectors in seemingly the same position in space as before. As the flickerings of the light occur several thousand times per minute, the phenomenon appears as continuous. When, however, the rotor lags, the sectors have sufficient time to move over only part of the polar division, so that when the lamp again relights, the eye finds the sector in a slightly different position. This lagging is going on continually and the sectors appear to the eye slowly moving backward, while in reality they are moving with, and at the same speed as the rotor.

The number of apparent revolutions of the disk is a direct measurement of the slip, and the higher the slip of the motor, the faster are the sectors moving through the field of vision. In order to count the sectors more conveniently, it is advisable to limit the field of vision so as to see but one sector at a time. Assume a 6-pole, 60-cycle motor operating at 1130 r.p.m., and suppose that 120 sectors have passed through the field of vision in 1 min. With these figures, the slip of the motor and the actual frequency of supply may be calculated as follows:

With 120 sectors passing through the field of vision during 1 min., the motor skipped 120 alternations of the supply. As the motor has 6 poles, it required 120 ÷ 6, or 20 slip revolutions to skip 120 alternations. The synchronous speed of the motor was, therefore, 1130 + 20, or 1150 r.p.m., and the slip amounts to 20 ÷ 1150, or 1.7 per cent.

When the speed was measured the frequency of the supply was equal to 1150 times 6, or 6900 alternations per minute instead of the standard 7200 alternations, or 57.5 instead of 60 cycles per second.

Due to the rapid travel of the sectors through the field of vision, and the resulting difficulty in counting them, it is found that the sectored-disk slip meter is better adapted for 25-cycle motors and light loads than for high frequency and high capacity motors.

Vibrating Reed Slip Meter

This instrument, suggested by Prof. Perkins, of the University of Tennessee, consists, as shown in Fig. 2, of an alternating-current electromagnet connected to the same source of supply as the motor under observation, and provided with a steel reed near one of its ends. One end of this reed is located with a weight so as to make its natural period of vibration correspond to that of the supply circuit.

A disk with a slot in it is mounted on the motor shaft, and the vibrating reed viewed through this slot. If the motor runs synchronously, the reed will appear stationary to the eye, due to the fact that it is viewed by the observer always during the same part of its vibration. If, however, the motor lags behind synchronism, the reed will appear to be slowly moving up and down. The number of strokes thus observed will be proportional to the slip the same as in the case of the arc lamp slip meter.

It is possible that the reed may vibrate at a frequency some multiple of the source of supply, and it is, therefore, better to calibrate this instrument by measuring the slip of a motor by some other type of slip meter. A constant will thus be obtained by which the number of strokes of the reed may be multiplied to give the number of alternations skipped per minute.

On Mar. 17 a flywheel in the No. 1 rail mill of the Illinois Steel Co. plant, So. Chicago, Ill., suddenly burst while in regular operation, sending large sections through the roof and into various parts of the mill.

The wheel was 25 ft. diameter and weighed 25 tons. No warning came of the rupture. It resulted in collapse of part of the roof, smashing of shafting and steam pipes and other damage to the extent estimated at $50,000. One workman, Bruno Oleschek, was killed and 4 others injured.

Power Development at Roosevelt Dam

IRRIGATION PROJECT AFFECTING 190,000 ACRES OF LAND AND POWER DEVELOPMENTS TOTALLING 20,000 HP. BY A. P. CONNOR

THE federal project on the Salt River in Arizona is more familiarly known as the Roosevelt dam. The dam itself is, however, but a portion of the development and serves mainly to induce the results that are brought about by the other parts of the system. The Roosevelt dam is a tremendous piece of work, especially for a dam. It is 280 ft. high, and the length at the bottom is about 240 ft., from which it gradually widens as it reaches the top, where it is about 1100 ft. wide. The dam faces the river that it obstructs with a convex construction, and it is built in handsome style of rubble masonry. The back of the dam is concaved and gradually diminishes from the bottom, in step style, until it reaches the top. The top of the dam is nicely finished off and leaves plenty of room for wagons to cross and turn around on.

FIG. 1. ROOSEVELT RESERVOIRS AND POWER CANAL

The means that is provided to permit the water stored by the dam, to flow down the river, consists of a system of balanced valves. These valves control outlets at the bottom of the dam and others situated at about halfway up the dam to its side. The outlets that are at the higher level serve to let the water out when water behind the dam is at a high level, and the lower ones when the water is low. There are many reasons for the use of such an arrangement, and one in particular is to relieve the lower valves of a continuous and high water pressure flow. These upper outlets were cut through the solid rock.

Valves are of special type and arranged to withstand the pressure put on them in a balanced way. The inlet in each case is circumferential and the discharge is central.

At the bottom and in front of the dam is the power house. It is of square and simple design and the rocky sides of the river bank serve to act as a wall for it. The power house is built in an angular direction with respect to the Roosevelt dam, and the transformer house is further down the river and built in a different-pointing direction. The buildings are real cave dwellings built on the side of the river bank and in a location where the

FIG. 2. POWER HOUSE AT ROOSEVELT DAM

old cave and cliff dwellers used to be. The general appearance of the surroundings can be partially appreciated from the pictures.

Water behind the Roosevelt dam not being suitable for the power purposes anticipated because of the variation in the levels that are apt to occur, and for other

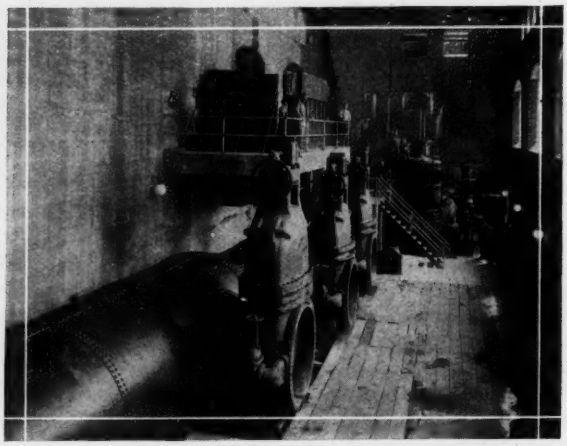


FIG. 3. INTERIOR OF POWER HOUSE BEFORE ALL GENERATORS WERE INSTALLED

reasons, was not depended on for power, but a canal was built from a point behind the dam, having a total length of 19 miles and terminating at the Roosevelt dam. The canal has a capacity of 250 second-feet and passes for a long distance above the Roosevelt reservoir, and is well illustrated in this relation, in one of the pictures. The

canal passes through a number of tunnels on its way in order to overcome difficulties encountered, and their total length is 11,000 ft.

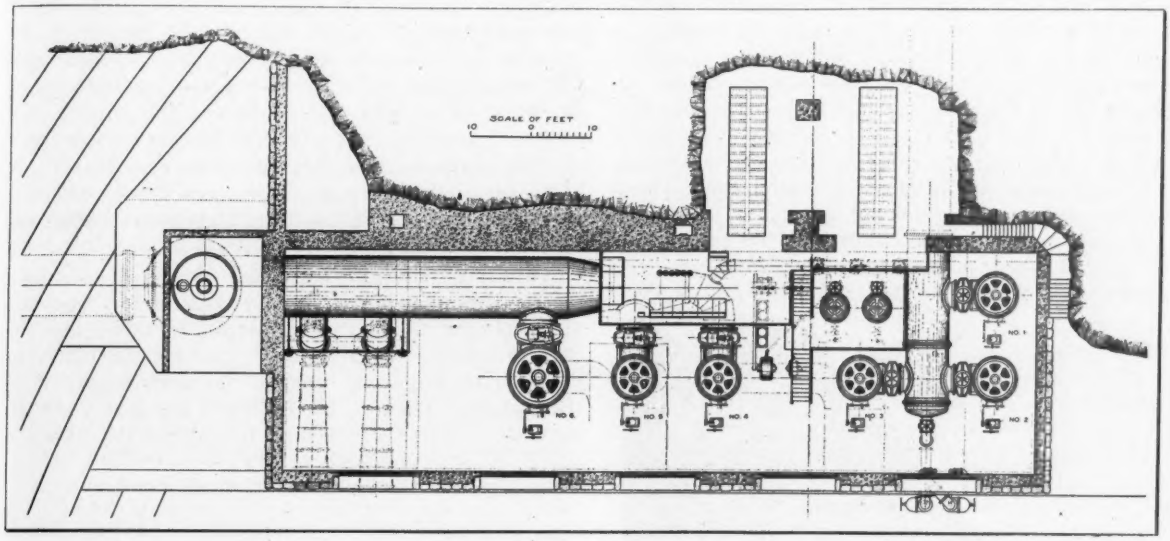


FIG. 4. PLAN OF POWER HOUSE

At 7 points along the canal, overflow weirs are provided for protection against high water. At 3 different points sand boxes have been provided to collect sand, silt, etc., before it reaches the power house. The last of these settling boxes is located a short distance from the forebay. It is provided with sluice gates that are hydraulically operated, and so arranged that the box will clean itself.

Five sluice gates are provided in concrete depressions below the bottom of the canal, and each set of gates is capable of discharging the full capacity of the canal. It has a maximum capacity of 250 second-feet. In spite of the precautions taken, the great amount of grit which gets into the power turbines wears out their parts rapidly.

The penstock that runs from the power canal is 620 ft. long and runs straight through solid rock, with the exception of one elbow of 49 deg. on a radius of 50 ft. near the bottom of the penstock. The lower end portion terminates in a horizontal steel manifold, which projects 27 ft. into the power house, and to which 3 vertical turbines are connected by 48-in. hydraulic operated valves. For the exciter turbine an 18-in. hand operated

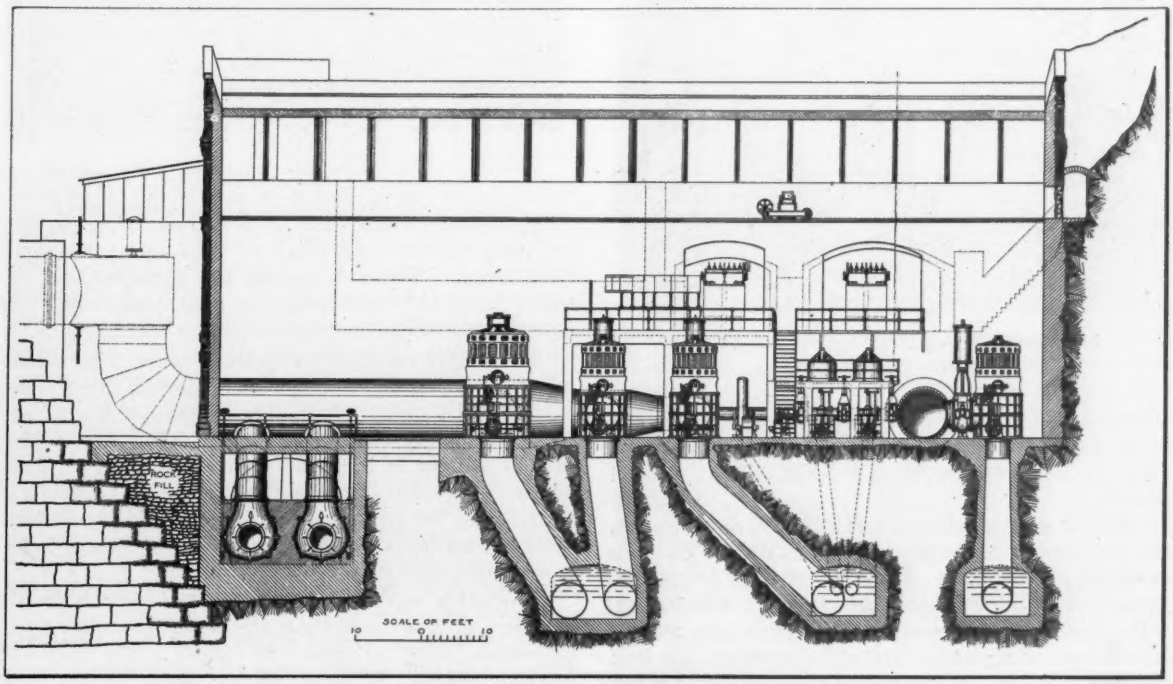


FIG. 5. LONGITUDINAL CROSS SECTION OF POWER HOUSE

gate valve is provided at its connection pipe. A 10-in. Lombard relief valve is connected to the bumped head at the end of the pressure main. The exposed portion of the manifold is designed to withstand heavy pressures, and is ⅝ in. thick. Above the elbow, the manifold is simply used to prevent seepage, the pressure being held by the rock through which the penstock or tunnel runs. The velocity of the water through the penstock at maximum is 7 ft. per second. Great difficulty was experienced in projecting the tunnel through the rock owing to the hot climate, and to the hot and sulphurous springs that were encountered in the rock.

Another penstock is also installed for using water from behind the dam, that is, impounded by it. This penstock is 10 ft. in diameter, and about 260 ft. long.

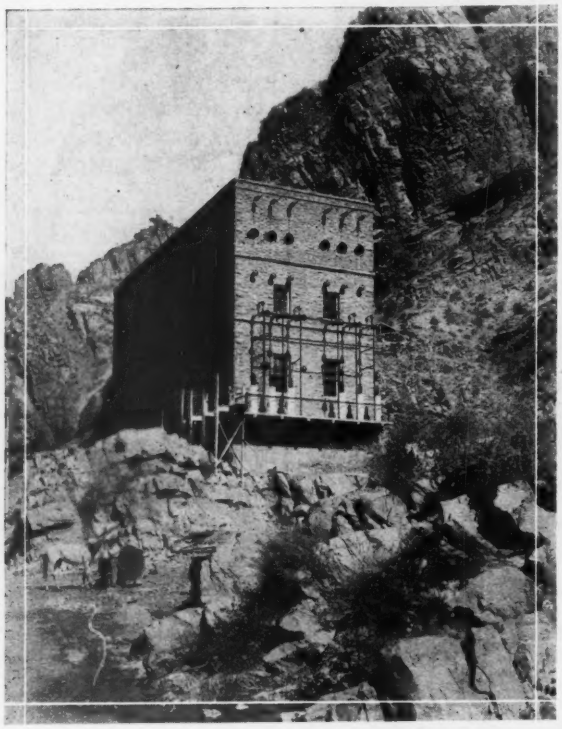


FIG. 6. TRANSFORMER HOUSE AT ROOSEVELT DAM, SHOWING DIFFICULT LOCATION

It works under a head of 75 ft. at the lowest, and higher as the water behind the dam gets higher. The power canal penstock works under a head of 225 ft., which is constant.

The first mentioned penstock is 7 ft. in diameter, and it is provided with 2 sliding gates to shut it off in an emergency, should it be necessary. The 10-ft. penstock is provided with a cylinder valve 16 ft. in diameter and 10 ft. high, for emergency purposes. This last penstock terminates in a horizontal manifold tapering to 5 ft. in diameter, to which are attached 2 42-in. balanced valves, 1 6-ft. gate valve, 2 5-ft. gate valves and an 18-in. gate valve connecting with the auxiliary exciter penstock.

There are 3 vertical turbines which receive water power from the power canal through the 7-ft. penstock. Their weight is carried by water thrust bearings, receiving their pressure from motor-driven pumps. At present there are 2 variable head turbines, and their weight is carried by roller thrust bearings. The turbines for the exciters are on the power canal penstock. The generator equipment consists of 5 3-phase, 2300-v. vertical generators, 25 cycle, and rated at 900 kw. at 85 per cent power factor. The exciters are 2 100-kw. 125-volt compound-wound exciters running at 1000 r.p.m. but designed to give full voltage at 700 r.p.m. The station is provided with a 15-ton hand operated crane.

This equipment will be doubled as the requirements make it feasible. The same project provides for 2800 hp. at South Consolidated, 1450 hp. at Arizona Falls, and 6000 hp. at Cross-Cut.

In the transformer house are 18 300 kv.a. single-phase, oil-insulated, water-cooled transformers installed in 6 banks of 3 each. The location is a bad one for electrical storms, which makes the electrolytic lightning arresters an important part of the installation. The transmission lines from the Roosevelt dam power station have had a number of mishaps; in one case about 2 miles

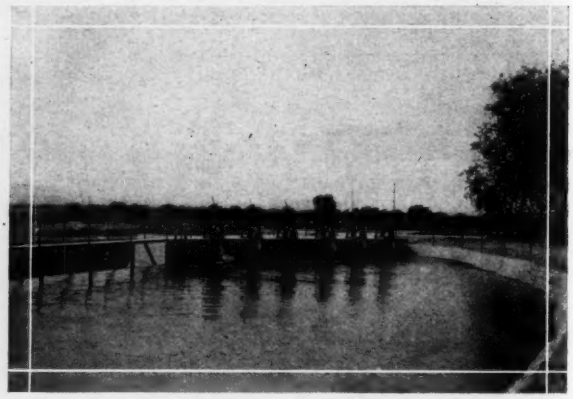


FIG. 7. VIEW OF SIPHON SPILLWAY FROM ABOVE

of up-to-date transmission towers, made of angle iron and with cemented foundations, were demolished by a wind storm. Water from the hot springs about the power house corroded away hangers used to support apparatus, and had to be replaced.

The main purpose of the power station at the Roosevelt dam is for the development of power to be transmitted to the high lands in Gila Indian reservation and in the Salt River Valley for pumping water from underground sources to be used for irrigation work. These points are 90 miles from the dam. There are contracts in existence at the present time that will yield the Government a gross income of $300,000 annually from the electric power developed by this project.

Two other smaller dams are included in the project and they all divert water into irrigation canals having an aggregate length of about 600 miles. The Roosevelt reservoir is about 25 square miles in area.

Waters of the Salt River and the Tonto Creek are those stored behind the dam. The valley is about 50 miles away from the dam, its greatest length is about 40 miles, and the width varies from 15 to 20 miles, gently sloping from the mountains to the Salt River, which flows in a southeasterly direction through the valley.

It may be interesting to note that there are accurate indications that this valley was irrigated in prehistoric times, and some of the present day canals have been run following exactly the same grades as these prehistoric and unknown tribes used. The systems used by these people were also of a very extensive character. This may be one of the reasons why the Government made such extraordinary efforts to proceed with this project so energetically and turn it into a momentous success,—lest future generations should deem this age one that was not able to turn into good account hints given by the prehistoric tribes and do something that such generations will have difficulty in improving on.

An Important and Unique Use of Siphons

An unusual yet none the less important, use is made of the siphon principle on the Government project with the Roosevelt dam. The siphons consist of inverted U-shaped pipes hanging over one of the auxiliary dams used in the project. They serve to drain the water back of this dam down to as low a point as desired.

The siphons work automatically, and as follows:—The water rises behind the dam as it fills and eventually reaches the top, and then overflows. At the same time it has filled the siphons and they commence to drain off. The water, after the freshet, recedes to the top of the dam; but the siphons keep working and continue their draining action until the siphon action is broken, which will not be until the water is below the level of the bottom of the siphon ends, on the dammed water side.

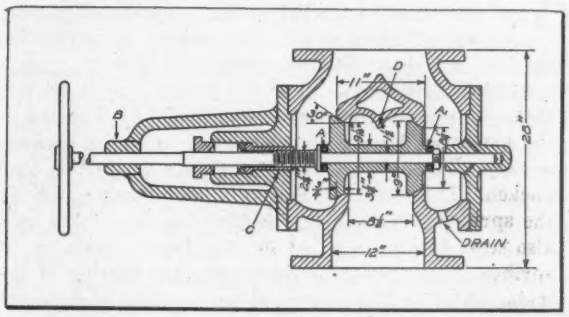
The level to which the siphons will drain the water back of the dam can be regulated by means of a screw arrangement which permits them to be raised or lowered. The siphons give a number of advantages to the dam, in that they permit a longer use of the water and they eliminate the necessity for a great amount of gates with their incidental troubles. They also permit a smaller dam to be used for backing up the water.

Ball Bearing Throttle Valve

By F. W. Salmon

UNFORTUNATELY, there are many engines fitted with throttle valves that are hard to open or close under the present high steam pressures; this not only increases the labor performed by the attendants, but at times may be an actual source of danger, for in case of an accident to the governor or its drive it may not be possible for the attendant to get the engine under control before a dangerous speed is reached.

The throttle valve shown here has many notable features, among which may be mentioned that it is extremely simple, almost perfectly balanced, and while the valve is loose on the stem, yet it has no material end play; hence there is no pounding from this cause when the valve is partially open. The valve is well supported and guided by the heavy steel stem supported at both ends. The valve is not ground into its seat like a corkscrew at each opening or closing, but here the axial pressure is taken on ball-bearings as shown at A and A_1. The flow lines of the steam are easy and natural with but little changes in area of passages and direction, leading to little loss by drop and curve and skin friction. The screw is of liberal proportion and the stress in it and the bearing pressure upon the sides of threads are light, leading to little wear and long life and great safety and being a right-hand thread, can be more conveniently cut and with less likelihood of error in the machine shop, and working in a threaded bronze bushing, the friction and wear are kept low, and new parts can be easily installed if necessary. From the design of the valve, all water can be drained from it before opening, whether used in the vertical or horizontal position, and can be kept drained from it. The valve being double ported, the valve seats are of comparatively small bore even for a valve as large as 12-in., hence the lift is small, 3½ to 4-in. being ample for this 12-in. valve; hence a rather fine thread, such as the Standard United States pitch, can be used. The seat having angles of 30 deg. with the axis provides against leakage from the spring of the valve or seat, or the effect of heat and expansion, and allows of a more gradual opening when starting up, and permits a more secure closing when stopping; and the stem, being in tension when on the point of opening from the pressure on the 2 discs owing to their differences in diameter, will remain straight and in true axis of the valve seats and operate more smoothly than if in compression. The body is a symmetrical cast-



SECTION THROUGH THROTTLE VALVE

ing without flat surfaces, and can be made strong without excessive thickness of metal or heavy ribs to cause expense in the pattern shop, defective castings in the foundry and other troubles in the machine shop, and perhaps breaks and other accidents in the field or later while in use.

As there is no grinding action between the valve and its seat, both the valve and the seat should be of cast iron, which best resists the action of flowing steam, each, therefore, having the same expansion, and reducing the expense compared with the bronze valves sometimes used.

A few men prefer the threads on the stem at the guide, B, in which case they can easily be put there, and the bronze bushing at C made smooth for a guide and support for the stem and slipped in without fastening.

It is sometimes interesting to know where something more or less similar has been successfully used before; for many years, valves have been used in locomotives having the double conical seats at 30 deg. with the axis, loose on the stem, under very high steam pressures (over 200 lb. per sq. in.) and steam velocities, and have proven most reliable and satisfactory.

The writer prefers hardened steel ball bearings that come from the makers self contained, with a light steel

case over them so that the whole ball bearing can be handled as a unit, without any danger of the ball getting out of the bearing.

It will be noticed that point D in the section shown, which forms part of the flow-line-surface, interferes with a line drawn from one seat to the other; but this point is only intended to be in the plane of the section here shown (not extend even 180 deg. around on the upper side) and while the writer considers it desirable to have this designed in this manner, if necessary it can be left off, although it will not interfere with passing the valve into the seat, nor will it interfere with reaming the bevels of the seats if it is desired to finish them with a reamer, provided the reamer is suitably made, namely with 2 reaming heads, and not with continuous long cutters.

Foreign Development in the Power Plant Field

JOLIVET ANTI-VIBRATION PLATE; HEAT CONDUCTIVITY OF REFRACTORY MATERIALS. BY J. H. BLAKEY

ANNOYANCE and damage caused by the vibration of machinery have led to the adoption of various methods of prevention. The Jolivet anti-vibration plate has been brought out recently in France, and is described by Mons. Moreau in the Bulletin de la Societe d'Encouragement. It consists essentially of 2 plates of cork, separated by spiral springs. The space between the plates is filled with packing of some kind; this may be wool felt, horse hair, cotton wool or waste, tightly packed. The purpose of the packing is primarily to hold the springs in position; but as it is treated with oil, it also serves the purpose of preventing the rusting of the springs. The cork is protected on the outside by sheet metal. The strength of the springs and their spacing will

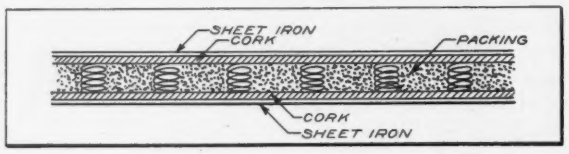


FIG. 1. JOLIVET ANTI-VIBRATION PLATE

of course be determined by the weight of the machinery, but it is advisable so to design the plate that the superimposed weight will be less than half load.

In the case of a steam hammer, the plate is placed between the foundation and the re-enforced concrete substructure; in addition, the foundation pit is lined with the plates, set vertically, to prevent lateral vibration.

HEAT CONDUCTING POWER OF REFRACTORY MATERIALS

SOME TIME ago, tests were made at the Berlin-Lichterfelde Laboratory for the Testing of Materials of Construction, on the heat conducting power of refractory materials such as are used in the manufacture of fireclays. The arrangement employed in the tests is shown by Fig. 2. The specimen is placed between other bricks of the same or similar composition, in such a manner that one face, A, is in contact with a heating plate, P, of some very refractory material. The high temperature is produced by means of an electric arc circulating through a mass of granulated coal. The other face, B, may be uncovered or may rest against another brick of the

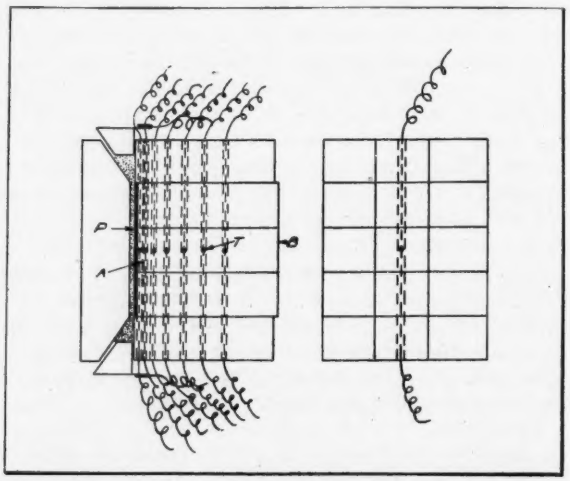


FIG. 2. APPARATUS FOR MEASURING THE CONDUCTIVITY OF REFRACTORY MATERIALS

same kind. The fall of temperature is measured by the thermo-electric elements, T, the first in contact with the inner face of the heating plate, and the remainder at varying distances along the axis of the brick.

The tests show that the conductivity of refractory materials varies with the temperature, and that this variation is not always regular. The accompanying table gives the coefficient of conductivity found for fireclays of different chemical composition. It will be noticed that the coefficient increases sensibly as the temperature rises, and that it may even double within a range of temperature between 200 and 1100 deg. C.

HEAT CONDUCTIVITY OF REFRACTORY MATERIALS IN GRAM-CALORIES

Temp. C	40% Alumina	30% Alumina	24% Alumina	97% Silica	89% Mangan. Ox.
200	0.0014	0.0011	0.0009	0.0013	0.0011
400	0.0018	0.0014	0.0011	0.0016	0.00115
600	0.0022	0.0016	0.0012	0.0017	0.0012
800	0.0024	0.0019	0.0015	0.0017	0.0013
1000	0.0026	0.0021		0.0018	0.0014
1100	0.0027			0.0021	0.0014
Spec. gr.	1.98	1.83	1.77	2.04	2.36

From Stahl und Eisen.

THE ANNUAL meeting of the National Gas Engine Association will be held at the LaSalle Hotel, Chicago, June 23 and 24, beginning at 10:30 in the morning. The Wednesday sessions will be devoted to the reports of committees on future work insurance, collection of data, and cost accounting. The Thursday sessions will be devoted to papers on the selling problems of the engine manufacturer, possible uses and some details. Thursday evening will be given up to a dinner. Arrangements can be made for accessory manufacturers to exhibit their goods by corresponding with the Secretary, H. R. Brate, Lakemont, N. Y.

Meeting of the Chicago Section A.S.M.E., March 19

A GOOD attendance was gathered about the tables at the La Salle Hotel to enjoy the dinner-meeting, and after due respects had been paid to this part of the program, President Neiler introduced Heywood Cochrane, who presented an illustrated paper on the manufacture of raw water ice by the absorption process, gave much interesting data, and showed views of plants where unusual results had been obtained by this system. A very clear explanation of just what the system is and how it operates was first presented, then some results as to the kilowatt-hours required in electrical driven plants per ton of ice capacity in 24 hr. This varied from 30 to 60, depending on the size of the plant and the methods pursued in freezing. He mentioned one clever method of thawing the ice cans in such a plant where steam was not available. After it left the condenser and before being cooled, the distilled water was used to heat water in a tank by means of coils, and into this tank the ice cans were dipped long enough to loosen the cakes from the cans.

He called attention, also, to the fact that in the absorption system it is essential to keep foreign matter out of the system. If oil, by any process, is carried over into the expansion coils, it will tend to stay there, also the water will stay there, because there is no suction of gas and liquid to draw it out, as in the case of the compression system, and any air which gets into the system will tend to collect in the condenser and stay there.

He also advocated in the use of the absorption system, particularly where high temperature water must be used, that direct expansion be used for cooling the rooms rather than the use of the brine system.

Following this paper was an address by Otto Luhr, consulting refrigerating engineer, who described the refrigerating process, and mentioned some points in operation of plants where he had found considerable ignorance and misunderstanding of just what is done by the refrigerating machine. He likened the refrigeration of rooms to a reversed heating process, the refrigerating medium taking up heat in the rooms from the air in the rooms, so that the expansion or cooling coils in the rooms perform the same function as the boiler in a heating system, while in the compressor and condenser or refrigerating plant, the heat is taken out of the refrigerating medium and carried away by the condenser water, this part of the plant carrying on the same process as the radiators in the heating system.

He mentioned a number of points which must be kept in mind, and where he had found failures in plants that had required his services. One thing is, that there must be plenty of ammonia in the system, so that there may be enough of this refrigerating medium to take up the heat as fast as required. In one plant he visited, he found that there was almost no ammonia in the system, or, at any rate, an entirely inadequate amount. Taking up this matter with the man in charge, this man said he knew perfectly well that there was but little ammonia there, but that it did no good putting any in, for it leaked out as fast as they put it in; and Mr. Luhr found, on investigation, that this was true, the whole difficulty being numerous leaks at various points in the system, and the remedy being to stop these leaks, after which a full charge of ammonia was put in and the plant ran satisfactorily.

Another point is, that the best efficiency of a compression machine is secured when there is a low head pressure, and as high suction pressure as can be used and secure the desired temperature in the rooms. The suction temperature to be carried depends on the refrigeration requirements, and is usually kept about 10 deg. below the temperature in the refrigerating rooms, while the head pressure depends on the temperature of the available cooling water, and must be kept high enough so that this cooling water can take heat out of the compressed gas.

In general, the absorption machine requires, for economical operation, plenty of cooling water, at a reasonably low temperature. While it can be worked, as shown by the previous speaker, with a moderate amount of water at high temperature, and by the use of cooling towers, this is not the ideal condition for this type of machine.

The absorption system should, also, have plenty of exhaust steam for heating the rich liquor. The carbon dioxide system is desirable in crowded places, such as the basements of hotels and office buildings, and on shipboard, where a leak and the escape of ammonia gas might be uncomfortable or dangerous. The compression machine is desirable where water is scarce, and high pressure steam is available for the power source of the refrigerating system.

It should be remembered that in any refrigerating plant, the best of care is required all the time to keep the machinery in good working condition, and it should be remembered, also, that all parts of the plant must be kept working at good efficiency to give a good, all round result. A poor boiler equipment can entirely overcome the advantages of an exceptionally good refrigeration equipment.

President Neiler then introduced Fred Wittenmeier, who spoke on the use of the carbon dioxide system, stating that his company had found it desirable to limit its activity specially to those fields which particularly desired this system in places where the space was crowded and the ammonia fumes would be objectionable. He stated that this system should have direct expansion used for the cooling of air, as in the refrigerating of storage rooms, or cooling of auditoriums and that it can work well with even a high temperature of cooling water up to 85 or 86 deg. He believed that the critical temperature of carbon dioxide as given by the various authorities has been placed too low, since this temperature has been given at around 80 deg. F., and if this were true, the system could not work with cooling water at 82 to 86 deg. Under normal conditions, the efficiency compares well with that of the ammonia or sulphur dioxide systems. Large coolers and condensers should be used, and results obtained will then be good.

He showed that where this system had been used in some plants for the refrigerating of the air of auditoriums, the air supply being 9000 cu. ft. a minute, the

outside temperature 91 deg., with 50 per cent of the air re-circulated, and the inlet temperature of this air at the register from 52 to 56 deg., the inside temperature was maintained at 73 deg. The condensing water temperature varied from 84 deg. to 106 deg. The machine was of 60 tons capacity, with a pressure on the high side of 80 atmospheres, and on the low side 30 to 34 atmospheres. They had found it desirable to use steel forgings for the compressor cylinders in order to carry the high pressures, as the procuring of steel or iron castings which would not leak gas had proved almost impossible.

Next was a talk by Mr. Lloyd, of the Commonwealth Edison Co., on the use of electricity for icemaking. He stated that there is at present 300,000 tons of ice made a year in Chicago by electric power, this being about 10 per cent of the ice used in the city. The raw water system is used where the water is pure, otherwise a distilled water plant is necessary. Because of the steadiness of the demand, it is found that the annual load factor is some 45 per cent in most of the plants, but even in the most favorable plant, it had never reached 65 per cent, although that was the estimated load factor before the use of electricity for this work was started.

The load supplied to ice plants is some 7000 hp., the power requirements being from 40 to 70 kw.-hr. per ton of ice capacity in 24 hours, and this current is supplied for icemaking at a rate of one cent per kilowatt-hour. As the refrigerating demand is large through the summer months, when the demand for current for lighting is small, the added cost to supply this current is, therefore, small, and the rate can be made correspondingly small. Mr. Lloyd stated that, under these conditions, the overhead charge against current supplied for refrigerating purposes was practically nothing.

Gardner T. Voorhees was then introduced, and read part of a paper recently presented before the Western Refrigeration Association, giving the results of the use of a device invented by Mr. Voorhees for re-circulating part of the gas at a temperature and pressure above that of consumption, thus increasing the capacity of the plant and decreasing the running cost. The system is based on the fact that the strength of refrigerant handled per hour determines the capacity of the compressor, and his system increases the volumetric efficiency of the compressor cylinder, thus increasing the capacity of the plant and reducing the power required. He stated that in the plant for the Quincy Cold Storage Market in Boston, where the system is used, 60 per cent more ice was made with the device in use than without it, and at an expenditure of 20 per cent less power, and showed similar results from tests in other plants.

Insulation

AMMONIA AND BRINE PIPES. BY A. G. SOLOMON

IN THE March 15 issue we dealt with the exclusion of heat from buildings and ice tanks. The leakage of heat into cold vapors or liquids contained in pipes or other apparatus must also be prevented.

A number of years ago, the covering of ammonia and brine pipe was not given much thought. When ammonia suction or cold brine lines passed through engine rooms or other warm places, pans were hung under them to keep the water from dripping on bright parts of machinery or on produce kept in other rooms.

If the benefits, due to insulation, were studied at all, a box was built around the pipes and this was filled with sawdust. As the air was not excluded, the sawdust soon became a wet mass or a solid cake of frozen material which in neither case was any good for the purpose intended.

Then the question of loss by the absorption of heat through these pipes was taken up and a study was made of it so that engineers and others could see almost exactly how many tons of refrigeration was being thrown away in cooling the outside atmosphere. The use of hair felt and pitch was the first result of this investigation. The frosted pipes were allowed to become dry and then given a coating of hot pitch; next came 2 or 3 layers of insulating paper and another coat of pitch; then 2 layers of hair felt (generally one inch thick) was covered with pitch on both sides and wrapped around the pipe. This was tied with wire or strong twine and over the whole canvas or heavy muslin was sewed. This made an air tight job and looked neat and clean when painted. Where such covered pipe passed outside of buildings or through exceedingly damp or steam filled rooms, they were protected with galvanized iron covering.

It is slow, hard work putting on hair felt properly and as better covering is now to be had, the hair felt is not much used except on small jobs. Another objection to this style of covering on ammonia lines is the difficulty of removing in case of a leak. The ammonia gets into the felt and the fumes are much worse than if there were no soft absorbing material to hold the vapor.

Now most ammonia and brine pipes are covered with cork covering, which comes in sections properly made to fit different size pipe and fittings. This covering is easily put on and is as near perfect insulation as possible. It is also quickly removed in case of a leak and in making changes on pipe work it can be taken off without destroying and can therefore be replaced.

In using cork insulation around flanges and fittings or other places where the ready shaped pieces do not make a close fit, a filling of cork, ground to a fine dust, is poured in to fill all empty spaces. A plastic filling composed of cork is also used in some places. After this sectional cork board covering is put on and the cracks plastered with the plastic filling, it is about absolutely air tight and moisture proof and the heat leakage into the vapor or liquid contained in the pipe is reduced to almost nothing.

In the ammonia compression system, every part (piping and apparatus) that is neither taking up heat from the goods to be cooled or giving up heat to the cooling

water, should be covered except in cases where the surrounding atmospheric temperature is a help. Now, starting from the ammonia compressor it will not be necessary to cover the discharge line to the condenser, as the gas in the line is hotter than the atmosphere. The condenser coils are giving up heat to the cooling water, so they do not need covering. The liquid line from the condenser, the liquid receiver and the liquid line to the expansion valves should be covered if the surrounding air is warmer than the temperature of the liquid leaving the condenser, which generally is the case, the receiver in most plants being located in the engine room. In cold storage refrigeration by direct expansion, the liquid line often runs through rooms or halls which are cold, and in such places the line must not be covered. Where the cold storage rooms are at a distance from the compressor, it is good policy to cover the liquid and suction line together.

After the ammonia passes the expansion valves, it enters the evaporating coils so no covering is needed, for this is the part of the system which takes up heat from the surrounding brine or air of the room to be cooled. After the ammonia has passed through the evaporating coils, it passes into the suction line on its way to the compressor. This line should be covered without fail, as the leakage of heat into the vapor results in loss in the capacity of the compressor.

In direct expansion cold storage, where the return from the coils in a number of rooms connect into one main suction line, this main should be covered even though it continues to run through a cold part of the building which also requires refrigeration. This is not only on account of any absorption of heat but as a prevention to heavy, thick frost and ice accumulating, causing expense in its removal, or if it is neglected, the danger of the line starting leaks or even falling down owing to the added weight.

Now we have completed the cycle back to the compressor. Double-acting compressors are usually operated on vapor sufficiently saturated to keep them cool without the use of water jackets. Insulation is not used on double-acting compressors. The single-acting dry gas machines are supplied with water jackets to take up some of the heat of compression.

On at least one make of this type, the water jacket is short and extends down only about ⅓ the length of the cylinder. The rest of the cylinder is insulated with cork board. In this case, the cold vapor from the evaporating coils enters the lower part of the compressor and the added heat of compression does not occur till the piston is near the top of the stroke. The bottom of the cylinder contains vapor at a much colder temperature than the surrounding air or the water used in the jacket and is therefore insulated and not water-jacketed.

All brine or calcium lines from the circulating pump to the coolers or cold storage rooms and back to the brine tank should be covered. The water end of the pump should be housed in with a well insulated box.

The lines carrying the distilled or raw water used for filling the cans in an ice plant should be covered from the fore cooler to the hose that leads to the can filler. All water lines that pass through chill rooms or coolers need insulating to prevent their freezing.

Often we hear the expression that a certain cold storage room is a "bad one," meaning that it requires more refrigeration than another room of the same size and having seemingly the same conditions. This is often caused by leaking insulation of the walls, floor or ceiling or by the room being next to a much warmer one. If the latter is the case, more or better insulating material should be installed on the surface separating the 2 rooms. Or, again, this added refrigeration might be caused by what we might term negative or harmful insulation, by which I mean insulating of the brine or ammonia coils with ice, frost, sediment from the salt used in the making of the brine, or dirt which has accumulated perhaps for several years without cleaning off.

(To be continued.)

Cost of Steam

By M. K. Bryan

IN determining the coal cost of steam, the chart shown in the Practical Reference Tables has proven to be a convenience. The calculation necessary to determine the cost of 1000 b.hp.-hr. made with a definite boiler efficiency and with coal of a certain heating value is familiar.

The curves are used as follows in arriving at the result. Spot the heating value of the coal as delivered and follow the vertical line up to its intersection with diagonal passing through the boiler efficiency, from this point follow the horizontal line to its intersection with the curve of cost of coal per net ton, and then follow the vertical line through this point up to the top of the chart where the cost per 1000 b.hp. is read.

For example:

B.t.u. per pound of coal, 12,500 as delivered.
Boiler efficiency, 65 per cent.
Cost of coal per net ton, $2.00.

Locate 12,500 at the bottom of the chart, go up to the diagonal through 65 at the right of the chart, then go horizontally, to the left, to the curve of $2.00, marked at the lower right of the chart and then go to the top of the chart and read the cost, $4.10 per 1000 b.hp.

U. S. Civil Service Commission announces an examination for hull draftsman with experience in dredge design, on April 28 and 29, 1915, to fill a vacancy in the office of the Chief of Engineers, War Dept., Washington, D. C., at $1800 a year. The following subjects will have the relative weights indicated: Ship calculations, 20; practical shipbuilding, 20; ship drafting, 35; training and experience, 25. Applicants must have had 10 yr. experience as ship draftsman. A first-class technical college training will be accepted as equivalent to not more than 5 of these 10 yr. Some experience in dredge design is a prerequisite for consideration. Age, 20 yr. or over on the date of examination. Each applicant will be required to submit to the examiner on the day of the examination a photograph of himself, taken within 2 yr., securely pasted in the space provided on the admission card sent him after his application is filed. Apply for Form 1312, giving the title, Hull Draftsman (Male).

LETTERS DIRECT FROM THE PLANT

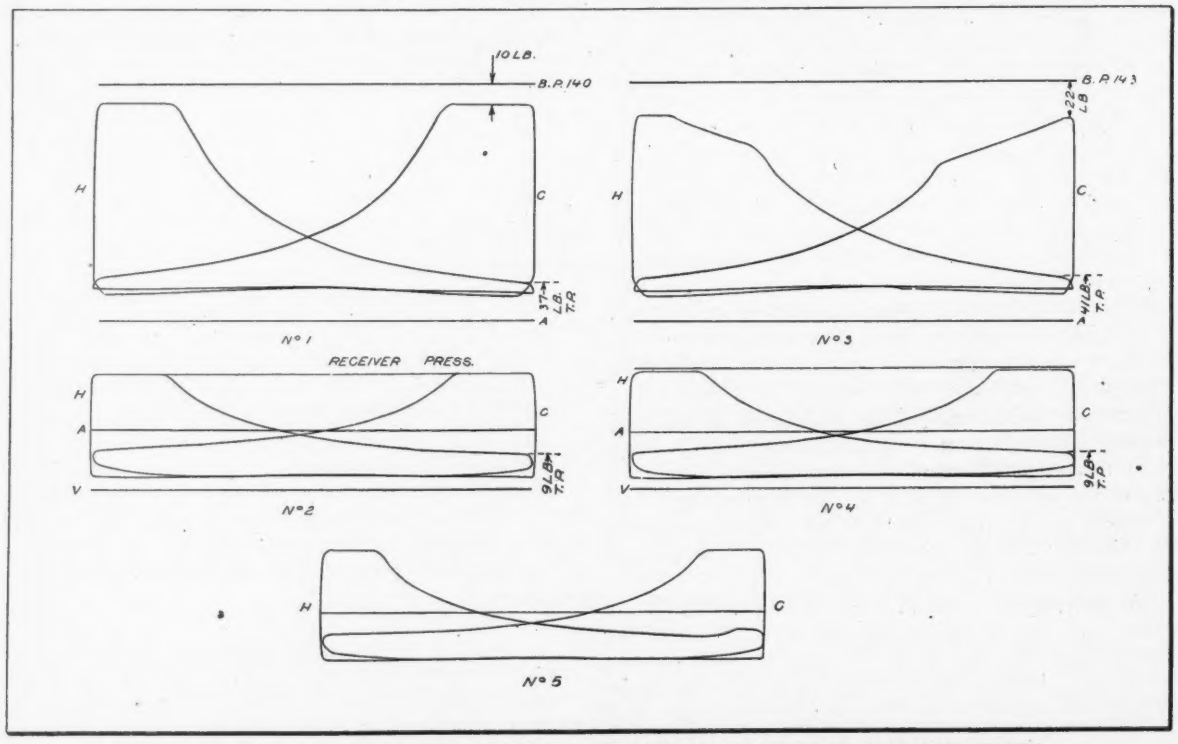
Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Advantages in Early Cutoff

THE ACCOMPANYING indicator cards were taken by the writer from a cross-compound pumping engine, the high-pressure cylinder being 12 in. diameter, low-pressure 24 in. diameter, 24-in. stroke. Both cylinders were equipped with Meyer cutoff valves, with a throttling governor on high pressure.

When the writer took charge of this engine, it was being operated as shown by cards 3 and 4, the cutoff valve being of no benefit on the high-pressure cylinder, as the engine was controlled by the governor as shown by the drop in the steam line, which would be about the card one would expect from a plain slide-valve engine. As shown by card No. 3, the boiler pressure is 143 lb. gage, the initial pressure being 22 lb. below the boiler pressure, with a terminal pressure of 41 lb. absolute, mean effective pressure being 44.1 lb., indicated horsepower 24.2 for this cylinder and 29.2 for the low-pressure cylinder, or a total of 53.4 hp. The cutoff valves were adjusted to cut off at ⅜ of the stroke on both cylinders.

Cards Nos. 1 and 2 were taken with the high-pressure cutoff set at ¼, the low-pressure at ⅜. This gives an initial pressure within 10 lb. of boiler pressure, and a terminal pressure of 37 lb. absolute, a mean effective pressure of 44.4 lb., horsepower 24.5 on high and 29.4 on low pressure, a total of 53.9 hp. with a well defined cutoff and a good steam line in the high-pressure cylinder. Cards 1 and 2 show 53.9 hp. with 140 lb. boiler pressure, while cards 3 and 4 show 53.4 hp. with 143 lb. boiler pressure; the speed in both cases was 40 r.p.m. More power is developed with the short cutoff on less boiler pressure, and less steam consumption per horsepower-hour due to the lower terminal pressure.



CARDS FROM PUMPING ENGINE WITH MEYER VALVES SHOWING ADVANTAGES OF EARLY CUTOFF

As shown by these cards, the low-pressure cylinder is developing more than its share of the power; this was corrected by a little later cutoff in the low-pressure side, thereby lowering the receiver pressure to about 12 lb., which equalized the load, the receiver pressure being 14 lb. when cards were taken.

Card No. 5 shows what may be expected if the cutoff is too early. The cutoff valve opens the port in the main valve before the main valve has closed the cylinder port, this readmission being shown by the rise near the end of the expansion line of the head end card.

R. L. MOSSMAN.

Imperfect Alinement Causes Knocking

I SHOW herewith, in an exaggerated way, why there is bound to be a knock in a crank, eccentric, etc., where the center of line of travel of the crosshead does not exactly bisect the center of the crank or eccentric bearing. This is true, even though the line of travel of the crosshead is at exact right angles with the crank shaft, and all other conditions perfect save alinement.

In Fig. 1, I show a connecting rod pushing the crank "out." Where alinement is not right, it is obvious that

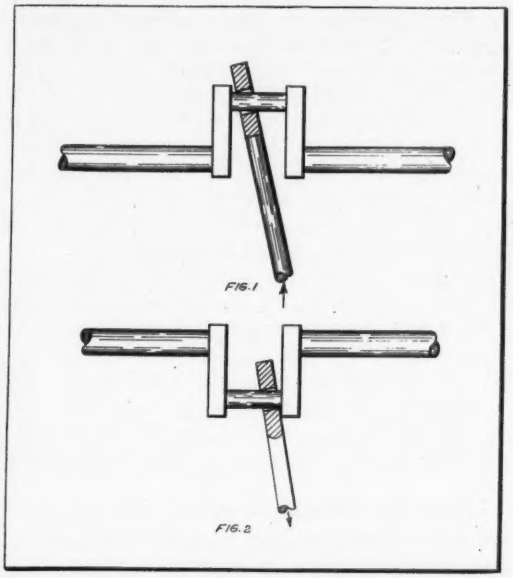


FIG. 1. CONNECTING ROD PUSHING
FIG. 2. CONNECTING ROD PULLING

the big end of the connecting rod will be forced over toward the left as shown. And when the crank arm is struck there will be a loud knock.

In Fig. 2 I show the same connecting rod pulling the crank "in." At the beginning of the stroke the big end will strike the other crank arm with another bang. And there you are.

Good alinement means least friction and where there is no sideplay there will be no knocking. N. G. NEAR.

Driving Shaft with 2 Engines

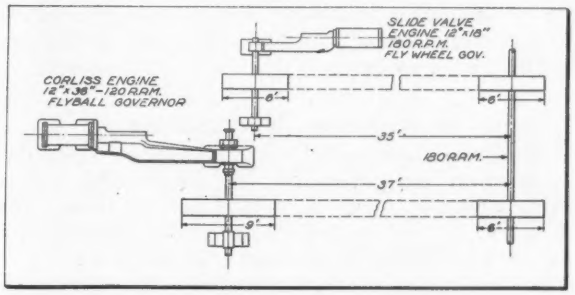
I HAVE heard a number of discussions lately as to the possibility of 2 engines of different size and type of governors driving the same shaft.

For instance, we will assume that the Corliss engine in the sketch is overloaded, and as we have the other engine idle we propose to let it help out the loaded engine. I would say that it could practically be compared with 2 men riding and propelling a tandem bicycle. Their actions, under any condition, as far as motion is concerned, are similar.

In case of the bicycle, we will conceive that one man is capable of pulling more than the other. Nevertheless, as long as the other man is giving out any energy whatever, he is helping carry the machine.

For a given speed, if one of the men has a tendency to carry more than his portion of the load, the other man quits giving out energy. In this way the speed is kept constant. In reference to the engines, if their load is lightened and they have a tendency to over speed, this additional speed calls for a greater centrifugal action of the governors which cut down the steam consumption.

In case the engines have a tendency to reduce in speed due to excess load, the action of the governors will admit a greater quantity of steam and the normal speed will be maintained. If, for some cause, the small engine's governor should become inoperative and allow full head of steam to the cylinder, there would be no runaway or damage done for the reason that the large engine would pull less (due to governor action). This would throw an overload on the small engine.



PLAN OF ENGINES AND SHAFTING

I have heard a great many engineers claim that the 2 engines will not synchronize. I should not think there would be any trouble experienced in getting them to do that. The only possible trouble that could arise would be due to a sudden stopping of the big engine, caused by a failure of some of its valve mechanism. This would throw the full load on the small engine. This, in all probability, would cause the engine drive belt to run off.

I hope some of the readers of Practical Engineer will give their ideas on the subject. J. W. DICKSON.

Economizing

AFTER READING the article on Summer Load in the March 15 issue, I thought a short description of the plant of which I have charge might interest readers, also, a change recently made to save coal, which has proved a success under the present conditions in the cotton industry.

The plant consists of one 2000-hp. Cooper Corliss cross compound engine, one 750-kw. Curtis bleeder turbine, 2 125-hp. water wheels. The switchboard is equipped with double throw switches, so you can throw load from different departments onto either turbine or engine.

The principal part of its duty is to carry load enough to hold back pressure at 10 lb. This steam is used for commercial work, heating buildings and heating water in a large National heater to 238 deg. F., the condensation returning through a Stetson trap to the receiver, where the boiler feed pumps take their supply. The usual load on the turbine to keep up this 10 lb. pressure is between 600 and 700 hp. in extremely cold weather.

Owing to business depression, our load has dropped from 2700 to 2000 hp. and less, which left a very light

load on the engine, and the high steam pressure of 170 lb., which is necessary to get the economy out of the turbine, made it uneconomical to run the engine. I wanted to cut the coal consumption; several schemes were thought of and one was accepted and proved a success.

The high pressure engine was to be disconnected from the low pressure. A 10-in. line was installed from exhaust of turbine and connected to the low pressure receiver, and the low pressure engine was run from exhaust of turbine. The records have proven this to be a success, as we are saving about 30 to 35 tons of coal a week. The turbine load now is usually 1000 to 1100 hp., according to demand for steam on commercial work. The low pressure engine and water wheels take the remainder of the load. I had a little trouble for a day or two in starting up and regulating the load; otherwise, the machinery runs as smoothly as ever and the firemen need not work so hard. SCOTTY.

An Improved Boiler Setting

A CAREFUL observance of the manner in which the air enters the ash pit when boilers are provided with a front as usually designed, with 2 ash pit doors, will show that the fire is comparatively dead within a triangular area between these doors as shown in Fig. 1.

This inactivity is due to the fact that the air in entering the doors does not evenly distribute and the currents pass rapidly toward the bridge wall so that an insufficient volume of air is admitted to the fuel at that point.

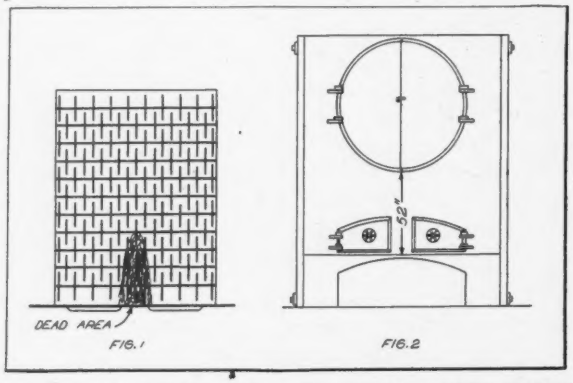


FIG. 1. DEAD GRATE AREA WITH USUAL BOILER FRONTS
FIG. 2. ELEVATION OF NEW BOILER FRONT

To provide for a better distributing of air, I cut out the front and removed the brick pier between the ash pit doors, with the result that the whole grate showed better combustion and as the draft was increased 0.1 in., it was desirable to reset the hand damper in the uptake.

The analysis of the gases showed a gain of some 0.6 per cent CO_2 on an average, which all confirms the opinion that a move in the right direction was made.

As new boilers were required, I had the builders change the patterns for the fronts to enable the boiler to be set 52 in. above the grate and have no ash pit doors, as shown in Fig. 2.

The cost of these and the increased cost of setting material was $109. When operated under daily conditions, these boiler showed an increased evaporation of approximately 1 lb. of water per pound of coal over boilers in same battery with settings in which the grate was 30 in. from the boiler and usual ash pit openings. The coal was analyzed by a chemist and the operations of both as nearly the same as possible.

A fire brick arch was sprung across the fire box from wall to wall and extending to the bridge wall. This showed a gain in evaporation of 0.5 lb. of water per pound of coal, so that the total cost of improvements is a decidedly good investment. RECEIVER.

Safe Governor Drive; Space Around Machinery

MR. CARRIE mentions an engine on which the governor was driven by 2 belts side by side, and states that he considers it a good idea because when one breaks it can be repaired and replaced without stopping the engine.

I do not think that a 2-belt drive would be as good as one belt of the same width as the 2 belts. If one belt of good material is used, it will run for several years without giving trouble, especially as the load carried by it is only a small percentage of that which it could safely carry; and when it does show signs of becoming rotten or oilsoaked, it may be replaced before it breaks with a new one at a small cost. In the case of the 2 belts, one will probably do the greater part of the work, as it is impossible to make 2 belts which will run on one pulley and have the same tension, and the slippage of one will throw additional work on the other one. Unless double cone pulleys are used, the belts will have a tendency to crowd each other, or one will ride on top of the other.

I believe that the proper way to drive a governor as used on Corliss engines and all other engines using the same class of governor, is through the use of bevel gears and a lay shaft. This drive is positive; it will last as long as the engine does; the chances of the engine running away through the belt breaking or slipping is eliminated. It would be a little more expensive to install, but would be an improvement over the present type. As this type of governor is used on some steam engines, and some of the large gas and oil engines as well as steam turbines, I see no reason why it could not be applied to any engine.

The trouble taken by Mr. Near to figure out the exact space required to get the armature out of this generator is interesting, as there are altogether too many cases where insufficient room is left to work around the machine, and for the convenience of the engineer in getting it apart.

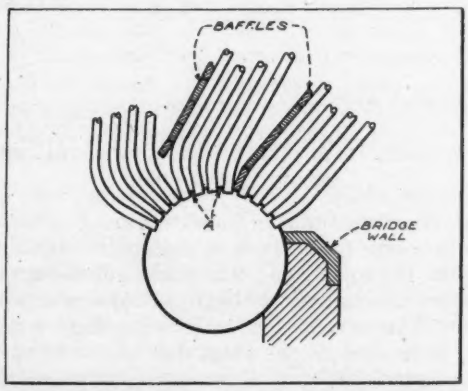
In our plant, which is considered modern, and which was designed by one of the foremost consulting engineers, we have a motor-driven ice machine with the end of the shaft so close to the outside wall of the building that the flywheel cannot be removed or the crank shaft taken out without moving the whole machine on the foundation. A foot more space could have been left between the wall and the end of the shaft which would permit the wheel being taken off. One of the motor-driven ventilating fans in the attic has a brick wall built within 8 in. of the end of the motor shaft. This gave no trouble until a few coils burned out and it was necessary to take the armature out. Then we had to cut a hole through the brick wall and take it out through this hole. This was no small job, as the motor was a 25-hp. slow speed and the armature was heavy.

There was no reason why the wall could not have been built out farther, or a door placed opposite the end of the motor. We also have a drip pump located in a pit, with the receiving tank placed crosswise of the pit on the floor and the water cylinder head of the pump within 12 in. of the tank. In order to get the piston rod out, it is necessary to remove both pistons, then the rod can be swung around to clear the wall back of the steam cylinder head, but the engineer cannot see into either cylinder on account of the tank on one end and the steps on the other end. The pit should have been made 2 ft. longer.

In some pumps of the outside packed plunger type the casting which connects the steam and water cylinder is of such shape that it is impossible to get a packing hook into the stuffing box below the plunger to get the old packing out, and it is impossible to get the new packing in as it should be on the bottom side of the plunger. This of course makes more work for the engineer, and he realizes these things where the designer does not. I have in mind one make of feed pump which has many good features to commend it, but which I should reject on account of inaccessibility of the packing gland. Consulting engineers and erecting men may not realize the importance of having plenty of room to get around the machinery, but the engineer who has to keep it in operation does, and if he was given any authority in the matter, would take special care to provide ample room for this purpose. J. C. Hawkins.

Beaded Tubes in Stirling Boilers

It is now the practice of the builders of the Stirling water-tube boiler to bead all those tubes entering the lower sections of the steam and water drums and those entering the upper section of the mud drum. Those in the upper drums are beaded to afford better drainage when the boiler is blown down, while those in the lower drum are beaded to avoid the presence of an air lock in the top of the mud drum.



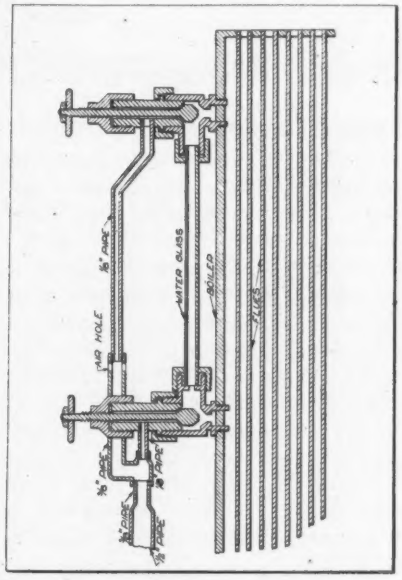
TUBES ENTERING MUD DRUM OF STIRLING BOILER; AIR LOCKS LOCATED AT POINT A

When those tubes entering the mud drum are not beaded an air lock will exist, but when such is the case no injury can result. Each time the boiler is refilled, a small quantity of air is trapped at point A, in the accompanying figure, due to the tubes protruding into the drum, and as the water rises this air is caught between the upper surface of the water and the shell.

Thomas Grimes.

Special Water Column Valves

I read F. R. Daly's letter in Practical Engineer of March 1 with interest; he gave several good reasons why a valve should be on the pipe line of a water column, and I agree with him.



WATER COLUMN OR GAGE GLASS VALVES ATTACHED TO VERTICAL BOILER

Herewith is illustrated a valve I invented, to be used on the pipe line to the water column. This valve will drain the water out of the water column when it has been shut off, giving the fireman a positive indication that the valve is closed. P. J. Creasey.

Correction

Our attention has been called to an error on page 309 of the Mar. 15 issue.

In the third paragraph in the article under the caption, Steam Consumption Calculation, the following statement was made: Join I and K by a diagonal and extend this until it intersects the atmospheric line at which point erect perpendicular NM, thus establishing the approximate clearance line.

The diagonal joining points I and K of the rectangle GIHK should be extended until it intersects the vacuum line and at this point of intersection perpendicular NM erected. It is this perpendicular which establishes the approximate clearance line and not the one erected at the intersection of the extension of IK and the atmospheric line as stated and as shown in the diagram.

W. A. Slater, First Assistant in Theoretical and Applied Mechanics in the Engineering Experiment Station of the University of Illinois, is conducting an extensive series of tests to determine the strength of gypsum as a building material. His tests include studies of the proper proportion of water to be used, and of various methods of mixing.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Proper Ventilation of Dormitories

I WANT your opinion on the size of air ducts or pipes and blower for the ventilating scheme I will now describe. The building I wish to try it on has 48 sleeping rooms of about 1900 cu. ft. of space each, and each occupied by 2 boys.

What I want to do is to install some kind of ventilating system which will furnish each room with the proper amount of fresh air for 2 occupants for both sleeping and living purposes, so that in extreme weather we can close up all windows.

All rooms are furnished with direct steam radiation and it was my idea to keep steam on these and have a tempering coil in the fresh air duct, so as not to cool the room too much. The size of this coil, or whether it is at all necessary, is a point that I am not sure about.

As shown in the accompanying figure the first floor has 15 sleeping rooms with an additional room used for shower baths and lavatories. The second and third

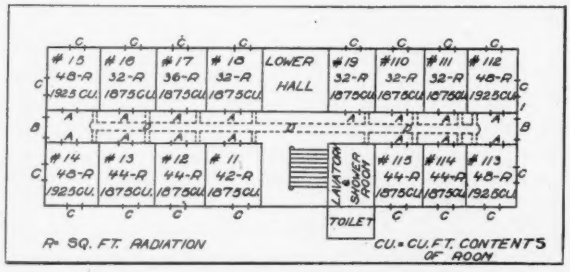


FIG. 1. PLAN OF DORMITORIES SHOWING NUMBER OF CUBIC FEET OF CONTENTS OF EACH ROOM AND NUMBER OF SQUARE FEET OF RADIATION SURFACE

floors are duplicates of the first except for a room above the space marked "Lower Hall."

A are standard size doors with a transom above each, opening into a hall, 8 ft. wide. B B are large windows at each end of the hall, while the approximate location of other outside windows is shown at points marked C.

Duct D is proposed to be used to discharge fresh air into the top of rooms with a foul air outlet at E. The tempering coil is to be located in the basement.

J. M. S.

A. In regard to the ventilation that you desire in the new barracks, as to the heating required, you will find an article in the Feb. 15 issue, which gives a brief, condensed method of calculating this, which is the best of anything I have seen.

I think, however, from a rough computation, that you have the direct radiation practically correct.

As to the ventilation, usually in school buildings, 1800 cu. ft. of air are allowed per hour per person. Probably a less amount than this would do in the dormitories as you have them planned; but, on the other hand, it is desirable to have a somewhat larger supply, if all air during the sleeping time is to be furnished by artificial ventilation. For conditions similar to those which you encounter in a dormitory, 2400 cu. ft. per person are allowed. I have assumed that, as a compromise, 2000 cu. ft. would be satisfactory.

The rule for getting the heat required is to multiply the temperature difference between the inside and outside air by the cubic feet of air required per hour and divide by 55.2. With 96 persons, you would have 192,000 cu. ft. of air an hour, which works out to 24,350 B.t.u. for tempering the air.

Roughly, we can figure on 240 B.t.u. per hour per square foot of radiator surface, which would allow about

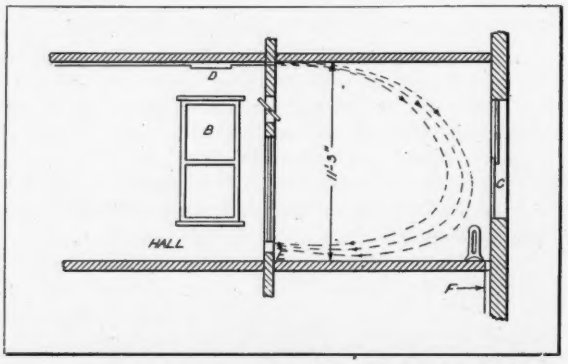


FIG. 2. SECTION OF ROOM SHOWING LOCATION OF PROPOSED AIR INLET, AIR OUTLET, RADIATOR, DOOR, TRANSOM AND OUTSIDE WINDOW

100 sq. ft. of radiation in your tempering coil. To be on the safe side, for an extra cold night, it might be well to put in 150 sq. ft., and this might cut down the use of the direct radiation, although the chances are (knowing something about boys) that what they would do, would be to turn on the steam full blast and open the windows wide.

As to the delivery of air to the room, it would be much better to put your register under or behind the direct radiator. In this way, the circulation from the ventilating current will be in the direction of the natural circulation over the radiator. If you try to discharge in the other direction, from the top of the room, through the room and down, you will be working against the natural flow of air from the direct radiation.

Also, if you send in the fresh air over the direct radiator, in moderate weather, you can cut out the tem-

pering coil entirely, and the direct radiation will heat the fresh air sufficiently. While, if you put the circulation the other way, you would not get the benefit of this tempering effect from the direct radiation; and also, with the transoms open above the doors, the tendency would be for the fresh air to double back close up under the ceiling and go out of the room, rather than circulating throughout the room. Of course, the tempering coil would be put in the basement in connection with the forced circulation fan, where it would be under control of the engineer.

As to the size of pipes required, we have 4000 cu. ft. of air an hour, or about 70 cu. ft. a minute for each room. Allowing 150 ft. per minute velocity through the register base, this gives about an 8 by 9 register, and with 450 ft. velocity through the riser pipe, it would give an 8 by 5 pipe.

The supply branch to each half floor, which would carry 32,000 cu. ft. an hour, would need a pipe about 10 by 20 at the large end, preferably tapered down at the point where each pair of rooms' supply is taken off, and the main vertical riser would want to be 16 by 36 rectangularly, or a 26-in. diameter round pipe at the bottom, tapering down as the floor branches are taken off.

As to the fan, from some tables issued by one of the fan companies, a flat blade fan with 32⅛-in. wheel, running at 450 r.p.m., would give a pressure at the fan outlet of ¾ in. water on the pressure gage, and would have some extra capacity above the 3200 ft. per minute required. A. L. R.

Boiler Questions

In a recent examination for an engineer's license I was asked this question; suppose yourself to be chief engineer of a plant and your employer buys a new boiler and orders you to ascertain if this boiler conforms in every particular with the requirements of the Massachusetts boiler law, you to have no samples of plate to test, or pay any attention to the boiler maker's stamps. How would you answer this question?

2. What would you consider the best method of cleaning a horizontal return tubular, or vertical tubular boiler, which is badly scaled? Also water tube?

E. E. A.

A. Horizontal tubular boiler without attachments and unset. Read the law. Take full and accurate description of boiler such as dimensions, thickness of all plates and heads, number and size of tubes. Calculate the square inches in segments of heads above and below tubes and in dome head. Find number of 1 in. area braces necessary to sustain the required pressure (thickness of heads not considered), note the kind, and calculate the strength of the horizontal seams. See that covering straps,—if a butt joint,—are properly laid up and are the required size and thickness, and if the work of construction as a whole is passable. Note the T. S. stamps and heat numbers on plates, heads, straps, and calculate the safe working pressure by the prescribed formula; note number and style of side lugs or hangers and how they are secured to shell; note size of blowoff pipe opening, position and size of safety valve, and water column opening, and position and condition of fusible plug. The finished boiler must comply in every particular with the law, with which you must be familiar before you can pass judgment on the work.

2. Use a good scale solvent, go inside, use hammer and scrapers and wash out thoroughly. If a vertical tubular, remove tubes, clean shell, clean and re-end tubes or replace well. D. O. Scott.

Dry and Wet Refrigeration Machines

What is an isochronous governor?

2. What, in refrigeration, is the difference between a dry and wet gas machine?

3. What changes are necessary when running a D slide valve engine condensing instead of noncondensing? D. A. U.

A. The isochronous governor is one which, if displaced from its equilibrium position, alternately swings from one to the other of its extreme positions, and keeps up this action indefinitely. It is, therefore, of no value for regulating the speed of engines.

The mechanical parts of this governor are so arranged that the height of the cone of revolution is the same for all positions of the governor balls.

The height of the cone of revolution is equal to 35,200 divided by the number of revolutions squared.

From this it will be seen that if h remains constant, n must remain constant, hence an isochronous governor, also, has the same speed for all positions of the balls.

Since the speed of the governor is directly dependent on and proportional to the speed of the engine, it follows that the engine speed must be constant for all positions of the governor balls. It is, therefore, one that keeps the engine running at a uniform speed, at all loads.

To fulfill this condition, the moment of centrifugal force must equal the moment of the spring, or weight, in all positions, at a given speed of rotation of the governor. An absolutely isochronous governor is, therefore, in neutral equilibrium, and is worthless so far as the speed regulation is concerned.

2. If ammonia vapor is compressed adiabatically, it will be superheated, as the work done on the vapor by the piston is stored in the vapor in the form of heat. This heat must be got rid of during the period of compression, since otherwise it must be absorbed by the condensing water before the vapor can be condensed. It is most economical to remove the heat as far as possible, as fast as it is generated, and to keep the temperature of the cylinder comparatively low throughout compression.

In what is known as the "dry" compression system, the gas enters the cylinder in a nearly saturated state. The instant that compression begins, the vapor would become immediately superheated if the heat were not carried off by the cold water surrounding the jacket. The majority of compressors built in the United States are of the water jacketed, or dry compression type.

In the "wet" compression system, the cylinder is not jacketed, but a certain amount of liquid anhydrous ammonia is allowed to enter the cylinder with each stroke of the compressor. The mixture of vapor and liquid remains saturated while it is compressed, since the heat equivalent of the work of compression is taken

up by the vaporization of a part of the liquid, and the vapor remains at the temperature due to the pressure.

The difference, then, between the dry compressor and the wet compressor, is that the dry compressor is water jacketed, while the wet compressor is not.

3. A slide-valve engine changed from noncondensing to condensing, would require no change in the valve setting if the governor were automatic; that is, if it changes the cutoff as the load changes. If there is a throttling governor, the valve should be changed to a shorter cutoff, as otherwise the governor would throttle down the initial pressure by an amount approximately equal to the reduction in back pressure. G. A. T.

Velocity of Steam

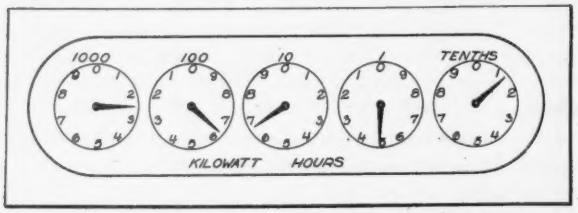
WHAT IS the greatest velocity at which steam should be allowed to flow? SUBSCRIBER.

A. The common velocities for steam are 5000 ft. a minute for high pressures, 6000 ft. a minute for low pressures. This is not logical, since the low pressure ought really to flow at a slower speed than the high pressure, but it has come about because of the excessive cost of exhaust piping due to the great volume of steam to be handled. The steam conductors would use as high as 8000 ft. a minute for high pressure superheated steam going from boiler to engine. A. L. R.

Reading Electric Meters

HOW DO you read an integrating watthour meter?

A. In the accompanying illustration, you will find represented 5 dials such as appear on the face of an integrating watthour meter. As you will observe, these dials have above them the markings, tenths, 1, 10, 100 and 1000, signifying that each division of the respective dials represents 1/10, 1, 10, 100 and 1000 kw.-hr.



DIAL FACE OF INTEGRATING WATTHOUR METER

When the meters are first placed in operation, all hands are set at zero. Then, as the energy is being measured, the hand of the tenths dial travels from zero to 1, to 2, to 3, to 4, etc., indicating an expenditure of 1/10, 2/10, 3/10, 4/10, etc., kilowatt-hour of energy. This hand continues to move until it has returned to zero, and has made one complete revolution.

It will be found that during this time the hand on the next dial has moved from zero to 1; thus, as the hand of the first dial has by its complete revolution indicated 10/10 kw.-hr., so has the hand on the 1 dial shown 1 kw.-hr., which is equivalent to 10/10 kw.-hr.

In a similar manner, the hand on the 1 dial will make a complete revolution (for every 10 revolutions of the 1/10 dial) during which time the hand of the 10 dial will move from zero to 1, thus indicating by that hand 10 kw.-hr.; by the 1 dial hand, 10 1 kw.-hr., and by the hand of the tenth dial, 100/10 kw.-hr., each being equivalent to 10 kw.-hr. This action is then continued until all hands again reach zero, when the process is repeated.

As shown in the illustration, the reading is 2665.1 kw.-hr. Not infrequently a hand slips and a slight displacement will be evident, as on the 1 dial, from the position of the next lower dial which indicates the fractional distance it should be between figures.

O. H. H.

Increase of Engine Speed

HOW WOULD you increase the speed of an engine having a Rites governor? I want to change the speed of my engine from 275 to 300 r.p.m. S.

A. Ordinarily the speed of an engine with a Rites governor can be increased from 275 to 300 r.p.m. by simply increasing the tension of the coil spring in the governor wheel. There are certain limitations and restrictions to this, however, for it may be possible that the speed limit of the spring has been reached, and that a larger one must be used.

Reducing the weights on the heavy end of the governor will also increase the speed, as will moving the spring pull pin outward in the slot on the governor bar; but both these methods are at the expense of sensitiveness and regulation. G. H. WALLACE.

Wattmeter Calculations

WITH REFERENCE to the question by C. D., on Wattmeter Calculations, appearing in the Mar. 15 issue, I wish to submit the following.

The kilowatt-hour load on any 2300-v. Westinghouse polyphase watthour meter operated with current and potential transformers may be obtained by multiplying the disk speed in revolutions per minute by a constant the value of which depends upon the ampere capacity of the meter.

This constant is derived by dividing the product of 4 times the capacity of the meter in amperes by the full load speed of the disk, which in this case would be 25 r.p.m.

We have, therefore, with a 5-amp. meter, the product of 4 times 5 divided by 25, or 0.8, which is the number of kilowatt-hours registered per revolution of the disk.

In a like manner, we have with a 50-amp. meter, the product of 4 times 50 divided by 25, which is 8.0, the number of kilowatt-hours registered per revolution of the disk.

Tabulating these constants, we have for the various size meters, the following table:

CAPACITY OF METER, AMP.	KILOWATT-HOURS PER DISK REVOLUTION
5	0.8
10	1.6
15	2.4
20	3.2
30	4.8
35	5.6
40	6.4
45	7.2
50	8.0

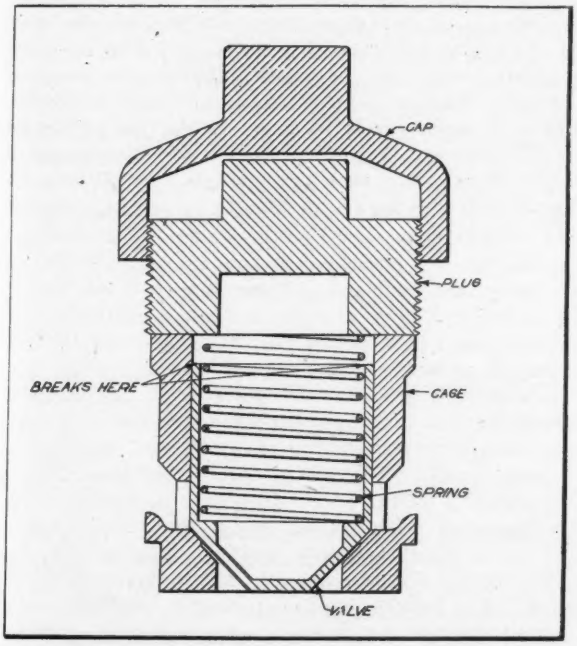
J. W. A.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Air Compressor Valve Breaks

I AM running a 2-stage, constant speed, variable delivery air compressor and am having some trouble with breaking discharge valves on the low pressure side head end; the intake valves are of the Corliss type.



CROSS SECTION OF DISCHARGE VALVE

The damage seems to be done as the valves lift, as it is always the top of the valve that breaks from striking the plug too hard. Could an error in setting of intake valves cause trouble in this way? J. D. D.

Boiler and Engine Questions

I DO NOT fully agree with G. A. T.'s answer on page 322 of the Mar. 15 issue. In answer to question 5, I would say, get a new spring and then regulate the blow-back. The Massachusetts Boiler Board made that ruling for 2 reasons: the seat will keep clean and it has a tendency to wear itself tight.

7. The talk about superheated steam in a vertical fire-tube boiler is more theoretical than practical, as this steam is in contact with the water and the moisture in the steam protects the tubes.

CHAS. MAGNUS.

Care of Boilers

IN REPLY to F. O. B., page 324 of the March 15 issue, on the care of an idle boiler, I advise the following treatment. A good manner to use in laying up a boiler for a period is to drain it thoroughly and remove the manhole plates; scrape the tubes and brush the exterior surfaces of all accumulations, since these will cause moisture to collect and attack the outside surfaces of the metal.

A tray of unslacked lime may be put inside the shell and others in the furnace and combustion chamber to absorb moisture. When the lime becomes slack, replace it. If of the water-tube type, it may be advisable to remove the caps from the lower row of tubes to promote air circulation through them, the headers and nipples. The disadvantage of laying up a boiler in this manner is that should it be required on short notice, considerable time is required to get the boiler in service again.

In some instances, it may be considered more advantageous to lay the boiler up in some other way in which it could be put on the line at short notice, the time lost in getting the boiler in service being greater than the deterioration the boiler would sustain. These considerations must be weighed when laying the boiler up after a plant has been in service some time, especially those in which the valves in boiler piping are difficult to repair, it will leak and allow such dripping to fall in the tubes or shell, where it will soon start pitting, and after trickling over the other surfaces, causes pitting or corrosion.

When the feed water is good or a good compound is used and the main stop and feed valves are known to leak, it is advisable to hold the water line at about the normal working level. Then any leakage as outlined can do no harm.

One thing that is too often neglected when laying up a boiler is to examine the blowoff pipe to see that the wall or sleeve that protects it is in good condition and fulfills its purpose and that neither the boiler or walls have settled to throw any weight on the blowoff pipe.

RECEIVER.

Protection of Steel Tanks

WHAT IS the best protective paint to use on the inside of steel water tanks?

What is the best way to mix red lead so it will remain for a reasonable length of time in a workable condition without precipitation? T. U. O.

PRACTICAL
ENGINEER

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Operating Tests

For the advancement of efficiency in the operation of power plants too little thought has been given by those in charge to the value of tests under operating conditions. This statement does not apply to central stations to a great extent, but in the vast majority of isolated industrial plants nothing more than a most superficial acceptance test, if any, is made of machinery installed, with the result that there is little on record to show what should be expected of modern equipment, excluding generating units and boilers.

It has been pointed out in these columns before how the manufacturer has been the real aggressor and champion of efficiency, advancing his product to the top notch of perfection, whether that product be the large generating unit or the smallest steam specialty.

After the painstaking efforts of the manufacturer to put the best there is on the market and the care taken by the engineer in making a selection of equipment, the next step which one naturally would expect would be a series of tests under operating conditions of the various pieces of apparatus in the plant to see that guarantees are fulfilled and that the plant as a whole comes up to expectations. But once the plant is turned over, too frequently, only such apparatus as gives trouble is put through proper tests.

In how many plants will you find records of tests on boiler feed pumps, feed water heaters or condensing apparatus? Authoritative tests of boilers and generating units, even, under service conditions, are not common. True, all plants are not equipped with apparatus with which a really accurate test can be made, but provision should be made in every plant to run periodic tests which are sufficiently accurate to indicate the condition of apparatus and determine whether it is holding up to standard.

Manufacturer's tests of apparatus are valuable to the power plant engineer in making a selection of equipment, and as a standard with which to compare his results under operating conditions, but they certainly cannot take the place of actual working tests which should aid the engineer in his management of the plant.

To show how an industrial plant may be guided in its choice of equipment, we publish on another page of this issue an article by Percy Q. Williams, giving a report of tests on vacuum pumps to determine whether the single-stage or the 2-stage pump will give better results. The conclusions drawn are well stated and need no further comment, except that the selection of equipment for a new plant was based on the results of these tests.

Government Power Plants

Politics enter so largely into enterprises undertaken by our government that the engineer not in the service is likely to look upon the project as a political scheme to raise votes for the administration in power and not as an engineering proposition with a commercial end in view.

The Roosevelt Dam in Arizona is a good example. From the beginning of this project, papers and general magazines have published many articles on the wonder-

ful engineering features of this project, referring almost exclusively to the civil engineering work, the dam being next to the seven wonders of the world, both in structure and importance to the community. Little, however, has been published in regard to the hydro-electric plant which is one of considerable proportions and presents many interesting engineering features. To acquaint our readers with this side of the project, Mr. Connor presents an article in this issue describing the general problem and principal equipment of the plant, which shows clearly that our government engineers have had many special conditions to meet and have been successful to a marked degree.

News Notes

ON MARCH 29, meeting was held at the Fort Pitt Hotel in Pittsburgh, called by the president of the American Boiler Manufacturers' Association, and by the president of the National Tubular Boiler Manufacturers' Association, to receive the report of the committee which has recently acted in conjunction with one from the American Society of Mechanical Engineers on uniform standard specifications of boilers. The chairman of the committee made the report and submitted the specifications, which were unanimously adopted, after which ways and means were discussed for furthering the use of these specifications, and inducing the various state legislatures to adopt them.

This places squarely back of the uniform specifications practically the entire boiler manufacturing industry, as well as the American Society of Mechanical Engineers, and it is gratifying to know that the work of those who for years have been trying to secure such a result has been crowned with success. The fact that the specifications were adopted by these 2 bodies of boiler manufacturers without a dissenting voice, emphasizes the fact that the work of the American Society Committee has been done well and faithfully, and that the specifications are as near right mechanically as it is possible to get them. A number of manufacturers announced that in future all their boilers will be made to correspond with these specifications, whether or not they are required to do so by state legislation, and one of the prominent boiler inspection companies reported, through its representative, that hereafter all its specifications will be drawn to conform to the A.S.M.E. standard code.

It is safe to predict that with such backing as this, the specifications will become universal throughout the United States in a very short time.

WORD COMES from the Engineers' Incitation Club, of St. Louis, Mo., that a protest is to be lodged with the Missouri Public Service Commission against the rates offered of one cent and 2 cents per kilowatt-hour to large users of power for the supply of electric current from the central station, as against the rate of 10 cents per kilowatt-hour charged to small users for power or lighting.

Protest is on the basis of rate discrimination, and that the current supplied at the low rates must represent a loss to the central station company, this loss being made up by the high rate charged to the small users. The services of Hon. Wm. F. Woerner have been engaged to present the case of the engineers and small power users, and the intention is to wage a strong fight to secure public protest and legal prevention of such wide variation in rate. L. A. Ragan, President of the Incitation Club, has sent out a call for contributions to the fund for paying the expenses of this campaign.

THE OHIO BOARD of Boiler Rules, at their meeting on March 25, 1915, adopted the following resolution:

"Until further notice, an Inspector holding a Certificate of Competency and a Commission authorizing him to inspect steam or hot water boilers which are to be installed within the State of Ohio, is hereby authorized to inspect during construction, and on completion stamp OHIO STD with Serial Number any boiler constructed in accordance with Rules formulated by the Boiler Code Committee as submitted to the Council of the American Society of Mechanical Engineers on February 13, 1915."

FOR THE territory comprised by Kansas, Nebraska, Southern part of Iowa and Western part of Missouri, the McIntosh & Seymour Corporation, of Auburn, N. Y., has appointed as its agent, Stanton A. Hadley, 621 Delaware St., Kansas City, Mo. Mr. Hadley is interested in the machinery supply business of Hadley-Hudson Co., Kansas City, but in the future will devote his whole time to the sale of McIntosh & Seymour Diesel type engines and steam engines and Goulds pumps.

THE E. KEELER CO., Williamsport, Pa., has, after a long series of experiments, perfected some interesting models of the Keeler water-tube boiler. These models are constructed largely of glass and are so arranged that the circulation is clearly visible both in the tubes and the drum. Many interesting facts are demonstrated conclusively with these models under steam pressure. The model of the Keeler cross drum boiler is particularly interesting from an engineering standpoint and clearly shows why this type furnishes such dry steam. These models were exhibited by Mr. Lippincott before the Manhattan Association, N. A. S. E., on Feb. 13, and proved highly interesting to the members.

N. H. BROWN, formerly the Chicago representative of the Bury Compressor Co., is now employed as sales manager for the Erie Pump & Equipment Co., Erie, Pa., successors to the Northern Equipment and the Erie Pump & Engine Works.

O. L. REMINGTON, General Manager of Wm. McLean & Co., of Melbourne, Australia, with H. P. McColl, one of the company's engineers, is paying a visit to the United States for the sake of becoming acquainted with apparatus in the line of electric and mechanical power machinery. The company handles at present Wagner's a.c. motors and Stirling d.c. motors. Messrs. Remington and McColl expect to be in St. Louis and Chicago the middle of April, at the Planters' Hotel and Hotel La Salle. They will then go to the Gibson House, Cincinnati; Hotel Statler, Cleveland; Hotel Astor, New York, spending some 2 months in visiting manufacturing plants through the central and eastern part of the country. Those manufacturers who wish to get in touch with them can address them as above noted. The purpose of the visit is to become familiar with the different products which may well be marketed in Australia.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Portable Fault Localizer

A PORTABLE fault localizer, for quickly locating a ground on a power cable, is now being marketed by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. The position of a ground is read directly off the dial in terms of per cent of length of defective cable. It is an application of the wheatstone bridge with all the necessary apparatus contained in one portable case wired for connection to the circuit to be tested. Its use assumes that the cable is grounded at one point and that a parallel conductor of the same length and resistance as the faulty cable is available.

After proper connections are made, a dial on the instrument is revolved by means of a knob in the middle of the localizer until the galvanometer shows no deflection when the key is closed. The reading of the meter then gives the percentage of length of the feeder from the point where the test is being made to the location of the ground, assuming the total length of the feeder to be 100 per cent; the red scale indicating that the ground is on the conductor connected to the binding post marked red, and the black scale indicating to the binding post marked black.

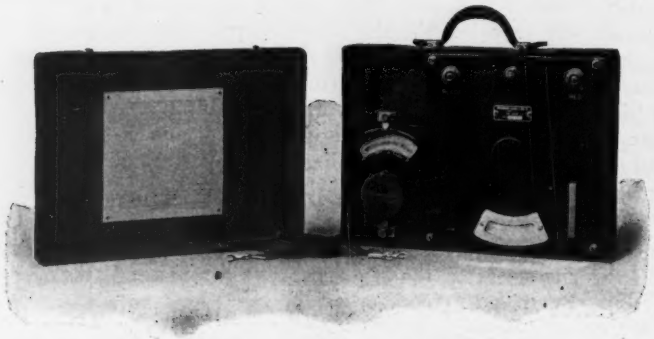


FIG. 1. WESTINGHOUSE PORTABLE FAULT LOCALIZER

Direct current only is used in these tests.

The fault localizer consists of a polished wooden case which contains all the parts necessary for the test except the source of direct-current supply and the leads to the cables. Two styles are furnished, one containing a galvanometer and the other for use with a separate galvanometer.

The variable resistance arms consist of 2 loops of low-resistance wire attached to the side of a revolving disk, upon which the dial is attached, so that contact is easily made from 2 brushes attached to the case and connected to the galvanometer terminals. As the disk is revolved, the point of contact between the brushes and the resistance loops is thus varied, as in the slide-wire bridge. The dial is calibrated in percentage of the length of the conductor tested, so that the reading is direct.

The galvanometer is highly sensitive, having a "unipivot" bearing which does not have to be leveled to take readings. It can be used for general testing wherever a portable galvanometer of its sensibility is desirable, and can easily be removed from the case when this is desired. It has a resistance of 5 ohms, full scale reading 0.000,36 amp., and sensibility 0.000,01 amp. division.

Cotton Waste by Brand and Sample

IN planning to put on the market its brands of cotton and wool waste, the Royal Mfg. Co., of Rahway, N. J., has adopted a distinctly novel method of insuring satisfactory treatment to those who buy its product. The quality of the waste is guaranteed to be as ordered, and this guarantee is accomplished by the use of a sample folder containing 12 grades of cotton waste, 6 white and 6 colored, from which the waste is ordered by name, the quality being guaranteed equal to the sample.

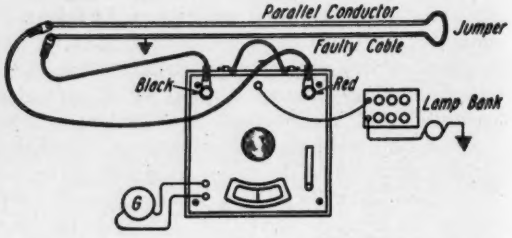


FIG. 2. DIAGRAM OF CONNECTIONS OF FAULT LOCALIZER

The second feature is that the tare, or wrappings, is guaranteed to be not over 6 per cent, the company offering to refund the difference on any bales which have the tare overweight.

A third feature is that the bales will be guaranteed of the exact weight ordered, and only the poundage ordered will be shipped to customers, so that there will be no excess billing or excess shipping.

The company has adopted a trade-mark which carries the slogan "Our Waste is your Gain," and the word "Royal" is stamped on the steel bands around the bale. Each bale is packed in clean, light burlap, and with new steel bands, insuring its delivery in good condition, and with the waste all clean and usable.

Hill Safety Gage Glass

TO read a gage glass on a boiler from a short distance and be sure the water level is where you think it is, frequently requires more than a mere glance. The importance of a positive and clear indication of the water level cannot be overestimated, and with this aim in view as well as the safety feature of the glass, the Hill Pump Valve Co., of Chicago, has developed the gage glass illustrated herewith.

The glass is surrounded by arms which are white on their inner edges which serve as a backing so that the glass can be easily read. The arms also prevent the glass being broken or knocked against, and pieces from flying should the glass break from any cause.

Funnel preventing condensation from touching sides of tube, keeping it clean.
Rubber Washer allowing glass to expand and contract without breaking.

HILL SAFETY GAGE GLASS SHOWING FUNNEL AND GASKET

To prevent condensation from running down the inside of the glass a little funnel is fitted at the top of the glass which causes the water forming above the glass to drop down the center of the glass, leaving the surface clean.

Another important feature of this glass is the gasket which prevents the glass from coming in contact with the metal and allows for expansion and contraction of the glass due to heat. Corrosion of the top of the glass is eliminated by the funnel and the gasket.

These glasses are made in sizes up to 30 in.

The Schieren Exhibit at the Exposition

THERE are few people who realize how many problems confront the user of belting. Limited space on many machines compels the use of narrow belts. Positions of shafting and machines to be driven and numbers of other unlooked for difficulties must be met; but when you have studied the practical demonstration of different forms of drive as shown in the exhibit of Schieren, in Machinery Palace, Panama-Pacific Exposition, Block 13, Corner Ave. G and 2nd St., you will agree that there is nothing like belt-driven machines where belt machines are in a fixed position.

NIGHT VIEW OF SCHIEREN BOOTH

Belting has greatly improved in recent years. Schieren's Duxbak waterproof leather belting is a step in the right direction, for it is able to keep its shape and size in all climates and under any manufacturing conditions it may meet, from the hot, dry air necessary in some cases to the wet, sloppy paper mill dye works or metal mills.

The belting shown in the night view of the booth is, of course, the important part of the exhibit, but the booth itself is interesting and attractive.

In the center of the booth is placed a basin 6½ ft.

in diameter, with a fountain. Connection with the water main is provided for supplying the basin. The water from the basin flows to a small centrifugal pump, which forces a stream up through the fountain. Upon the dome a Schieren belt 190 ft. long is arranged in a spiral, bearing the firm name of Chas. A. Schieren Company, and highly illuminated.

In the booth, machines and belt drives are shown, intended to demonstrate the application of Schieren belting to interesting drives. A 5.4-hp. 3-phase motor of 1440 r.p.m. drives Shaft No. 1 by means of a Lenix at 360 r.p.m. The rheostat has an automatic switch, which may also be worked from one of the corner columns. Shaft No. 1, by means of an overhanging pulley and 2 guide pulleys, drives a centrifugal machine. It also drives, by means of a belt, shaft No. 2, the belt running over a fixed idler pulley and a Lenix. The centrifugal machine runs at a speed of 1080 r.p.m., and this belt drive is especially characteristic and interesting.

Shaft No. 2, running 180 r.p.m., drives from one end a planer by means of a Bamag countershaft (with 2 pulleys) at 1200 r.p.m. On the other end, shaft No. 2 drives shaft No. 3 at 60 r.p.m. by means of a quarter turn belt arrangement with automatic tightener.

A cement tube mill grinder of 60 r.p.m. is driven by means of a simple countershaft. From the friction clutch pulley on shaft No. 3 a belt running over mule pulleys leads to a vertical shaft, from which the vertical shaft for the Lenix drive in the water basin is driven. A duck, representing the trade-mark of the firm, is fastened to the belt, which runs permanently in the water. From shaft No. 2 is driven also a centrifugal pump, which serves the fountain.

Book Reviews

SOME ELECTRICAL PROBLEMS Practically Considered is the title of a paper presented before the recent convention of iron and steel electrical engineers held in Cleveland, by B. G. Lamme, Chief Engineer of the Westinghouse Electric & Mfg. Co., and has been issued in pamphlet form by this company.

Mr. Lamme's experience in electrical matters has given him a wide knowledge of this subject, and the paper covers in an interesting and non-mathematical style, many of the practical problems met with in the operation of electrical machinery.

The particular subjects covered are insulation, commutation, including its theory, speed control, and choice of frequency.

The company will send a copy, as long as the supply lasts, to anyone interested in this subject.

VALVE GEARS, by Chas. H. Fessenden, 170 pages, illustrated, first edition. Price, $2.00. 1915.

The author of this book has intended it as an elementary treatise on the subject of valve gears rather than a reference book, the subject matter having been used in the classes of the University of Michigan for several years.

In the introductory chapter, the relative positions of the piston and crank, the valve gear of a simple high-speed engine, the action of the valve, steam lap, exhaust lap, port opening, lead, angle of advance, relative positions of valve, eccentric and crank are taken up, and discussed in a manner which would be understood by anyone in the power plant.

The Zeuner and Bilgram diagrams are then described and in the following chapter, typical problems are solved by the use of these diagrams. The headings of the other chapters are, Port Openings and Passage Areas, Forms of Slide Valves, Shaft Governors, Valve Settings, the Design of Slide Valves, Valves with Riding Cutoffs, Pump Valves, Reversing Gears, Corliss Valve Gears and Poppet Valve Gears.

The discussions throughout the book are concise and readily understood, but the author assumes a good knowledge of mathematics on the part of the reader. The book, however, would be of value to anyone wishing to become familiar with various types of valves and valve gears, and the problems which arise in the design and setting of various types of valves.

VOLUME II OF THE TRANSACTIONS of the International Engineering Congress, 1915, will comprise 2 series of papers, one on the subject of Waterways and one on irrigation.

The former subject will be treated under 4 general topics with possibly 2 additional if authors are found in sufficient time. These topics cover the general field of the province of waterways in internal commerce, economic aspects, physical features, natural waterways, towage and propulsion.

The subject of irrigation will be treated under 11 topics covering: Methods of handling irrigation enterprises; duty of water; relation between demand and supply; underground sources; stream sources; tail water from hydroelectric plants; regulations for use; methods of charge; metering; drainage; dams in general; and also recent developments in India and in the Argentine Republic.

In both of these general subjects, authors have been obtained representing practice abroad as well as in the United States. This is especially the case with the general subject of irrigation, where an effort has been made to obtain representative writers from the leading foreign countries in which irrigation plays an important part.

This volume as a whole will comprise from 20 to 25 original papers, profusely illustrated with charts, diagrams and halftones, together with discussions contributed by leading American and foreign engineers, and will form a most valuable acquisition to the library of all engineers and others who may be interested in these phases of engineering work.

The transactions of the Congress as a whole will include from 7 to 9 other volumes, covering the various fields of engineering work.

Membership in the Congress with the privilege of purchasing any or all of the volumes of the proceedings is open to all interested in engineering work.

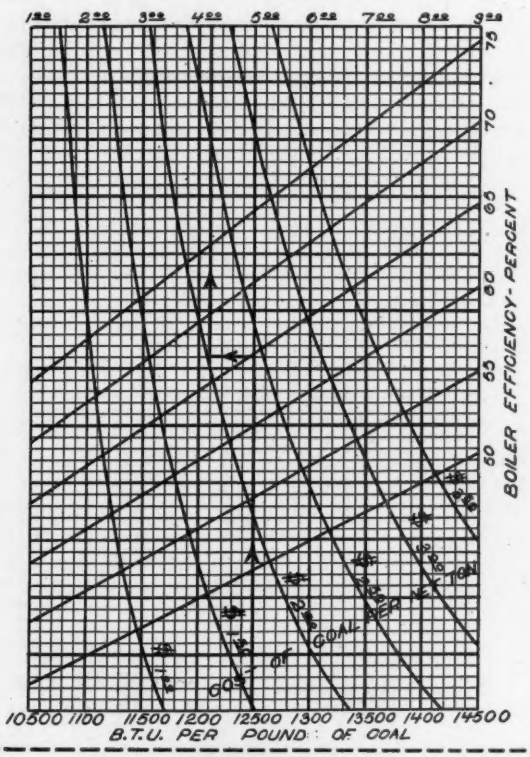
For full particulars apply to W. A. Cattell, secretary, 417 Foxcroft Bldg., San Francisco.

F. H. WENTWORTH, Secretary of the National Fire Protection Association, gave a lecture before the faculty and students of the College of Engineering of the University of Illinois on March 22. His subject was "The Economic Significance of Fire Waste."

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

PRACTICAL ENGINEER

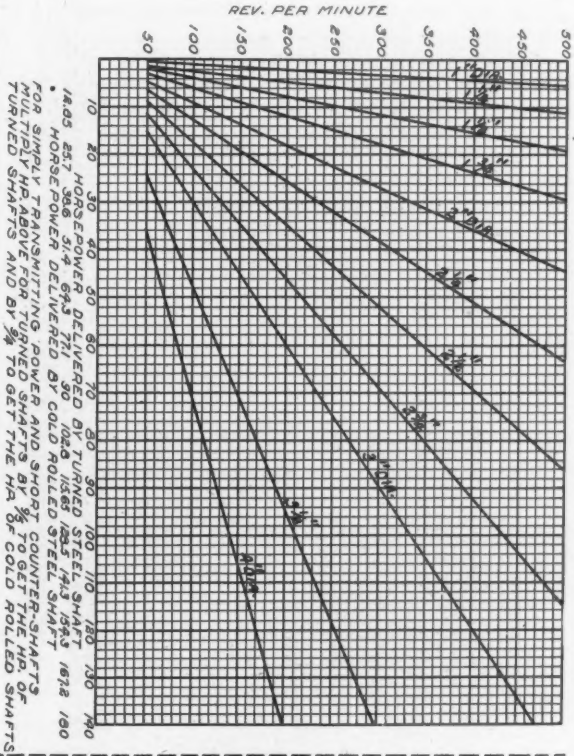
COST OF STEAM. By M. K. Bryan



PRACTICAL ENGINEER

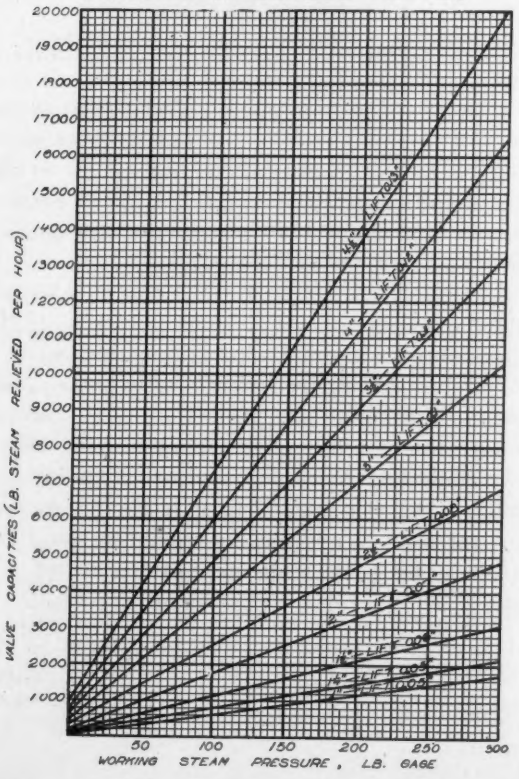
HORSEPOWER OF STEEL LINE SHAFTS

Bearings 8 ft. apart


REV. PER MINUTE
HORSEPOWER DELIVERED BY TURNED STEEL SHAFT
HORSEPOWER DELIVERED BY COLD ROLLED STEEL SHAFT
FOR SIMPLY TRANSMITTING POWER AND SHORT COUNTER-SHAFTS MULTIPLY H.P. GIVEN BY 1.25 TO GET THE H.P. OF TURNED SHAFTS AND BY 1.33 TO GET THE H.P. OF COLD ROLLED SHAFTS

PRACTICAL ENGINEER

CAPACITY OF SAFETY VALVES



PRACTICAL ENGINEER

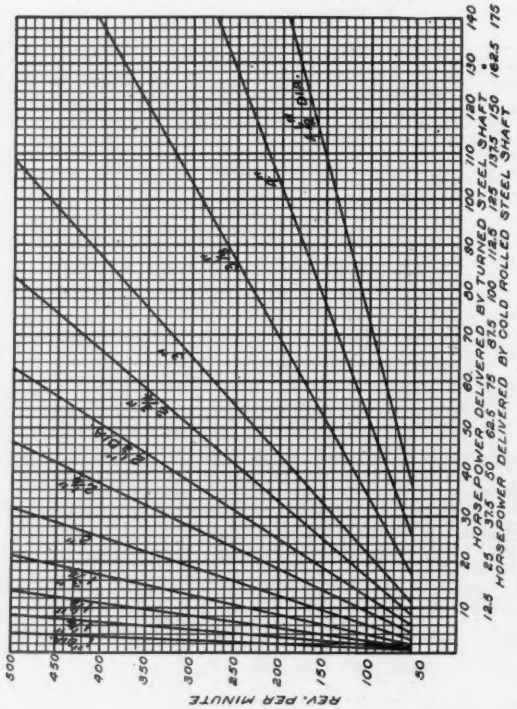
PRIMARY CELLS

Cell.	E.M.F.	Constituents.	Remarks.
Weston (replacing the Clark)	1·018(5) volts at 20° C. Constant.	+ Mercury and paste of mercurous and cadmium sulphates. − 12·5 per cent. cadmium and mercury amalgan. Electrolyte — satd. cadmium sulphate.	This cell is now used as the international standard of E.M.F.
Leclanché	1·47 volts, which rapidly falls with large current but recovers when out of use.	+ Carbon and manganese dioxide. − Zinc in a solution of ammonium chloride.	Useful for intermittent work. Deteriorates very slightly.
Bichromate	2 volts, which rapidly falls with large current but recovers when out of use.	+ Carbon — In a solution of bichromate of potash and sulphuric acid. − Zinc	Low internal resistance.
Daniell	1·1 volts. Constant.	+ Copper in a saturated solution of copper sulphate. − Zinc in dilute sulphuric acid.	Current remains constant for a long time and the cell deteriorates but slightly.
Bunsen	1·9 volts. Constant.	+ Carbon in strong nitric acid. − Zinc in dilute sulphuric acid.	Deteriorates.
Grove	1·7 volts. Constant.	+ Platinum in strong nitric acid. − Zinc in dilute sulphuric acid.	Deteriorates.

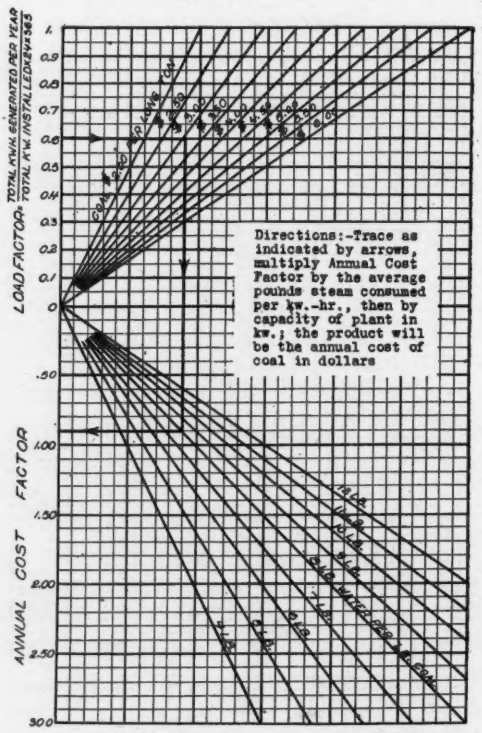
—Mechanical World Electrical Pocket Book.

HORSEPOWER OF STEEL PRIME MOVER AND HEAD SHAFTS

Carrying Main Driving Pulley or Gear, Well Supported by Bearings



ANNUAL COST OF COAL


LOAD FACTOR = TOTAL KWH. GENERATED PER YEAR / TOTAL K.W. INSTAL. LEDX24X365
ANNUAL COST FACTOR
Directions:-Trace as indicated by arrows, multiply Annual Cost Factor by the average pounds steam consumed per kw.-hr., then by capacity of plant in kw.; the product will be the annual cost of coal in dollars

DRY CELLS

Dry cells are almost invariably of the Leclanché type. Types employing carbon and zinc as electrodes and the electrolytic and depolarising pastes stated are: Scrivanoff (1·5v.), NH_2HgCl, NaCl, AgCl and $ZnCl_2$; Dun (1·8v.), KOH, $KMnO_4$; Gassner (1·4v.), ZnO, $CaSO_4$, NH_4Cl; Wolff (1·33v.), $Al_2(OH)_3$, $CaSO_4$, NH_4Cl. The Gaiff cell (1·02v.) employs copper and zinc in a paste of $ZnCl_2$ and AgCl. Many millions of 2½-in. by 6-in. dry cells are now made per annum for use in iginition bell and local telephone circuits, etc.; millions also of miniature dry cells (13/16 in. by 2 5/16 in.) are built up in sets of three for use in hand or pocket flash lamps. Standard practice in the manufacture of these cells is to roll a containing vessel from 20 mil. zinc plate (to form— electrode); line this with 3 layers of blotting paper and pack the carbon rod electrode in place with a paste of the following composition (parts by weight): Pyrolusite (85 per cent. MnO_2). 100; ground coke, 80; artificial graphite, 20; sal ammoniac, 20; zinc chloride, 7. The MnO_2 acts as depolariser and the $ZnCl_2$ reduces local action, and hence extends the life of the cell. If provision be not made for the escape of ammonia, the cell will burst when its container becomes thin; should the paste dry out, the activity of the cell can frequently be restored by adding water or sal ammoniac solution. It is hardly worth while endeavoring to regenerate dry cells. Standard makes of dry cells now on the market provide about 1·5v. and, ranging from 2 to 8 lb. in weight, have a total capacity from 140 to 200 amp.-hr.; 100 to 155 w.-hr.; 25 to 40 amp.-hr. per lb.; 20 to 33 w.-hr. per lb.; and 1·6 to 2·5 amp.-hr., or 1·3 to 2·3 w.-hr. per cu. in. On short circuit, 20 amp. or over can be taken temporarily from a 7-in. by 2½-in. dry cell. The great practical advantages of dry cells are their cleanliness, compactness and cheapness.—Mechanical World Electric Pocket Book.

MAXIMUM EVAPORATION OF BOILER

To make a proper selection or check of safety valve sizes it is necessary to know the maximum evaporation of the boiler. When a test of the boiler cannot be made, the evaporation can be estimated at 6 lb. of steam per hour per square foot of heating surface for water-tube boilers and 5 lb. for all other types.

After the installation has been made, the capacity of the valves may be checked in one of 3 ways: 1: Make an accumulative test with all openings closed except the safety valves, forcing the boiler to its limit, the pressure should not increase more than 6 per cent above the pressure at which the valves are set to begin blowing. 2: Compute the evaporation capacity of the maximum amount of coal that can be burned in the furnace equipment per hour. 3: Weigh the amount of water evaporated during 1 hr. when the boiler is forced to its limit.

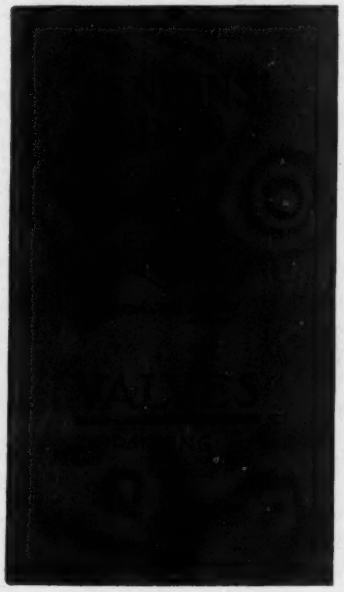
Catalog Notes

STEAM TURBINE DRIVES for Rolling Mills is discussed in a well illustrated pamphlet distributed by the DeLaval Steam Turbine Co., of Trenton, N. J., who recently installed the geared steam turbine driving an 18-in. 3-high roughing mill at the plant of the Carpenter Steel Co., Reading, Pa. Numerous photographs and drawings are given, as well as detailed information relating to the problem which was presented and the way in which it was solved.

GREENFIELDUCT, a hot galvanized conduit, is the subject of a booklet from Sprague Electric Works of General Electric Co., New York.

Other recent circulars list the company's electric fans for 1915.

JENKINS BROS. have just issued their catalog No. 20, which contains descriptions and price lists of all types of valves and packing made by this company. The book is well illustrated with halftones from photographs and washdrawings showing cross sections of the various valves and the descriptions are concise yet complete,



setting off the superior qualities of Jenkins Bros.' products. It is pocket size in cloth binding and thoroughly indexed, making a handy reference for a man on the job. Requests for this catalog should be addressed to Jenkins Bros., 80 White St., New York.

A LIST of the catalogs published by Schaeffer & Budenberg, Brooklyn, N. Y., is given in a recent circular from the company.

OHIO BRASS Standard J. D. valves for 150 and 125 lb. working steam pressure are illustrated in a new folder from The Ohio Brass Co., Mansfield, O.

VALVES, BOILER FITTINGS, tools, etc., are illustrated and described in Catalog No. 100 of John O'Brien Boiler Works Co., St. Louis, Mo.

A NEW SLIDING MODEL of the Simplex Seatless Blowoff Valve, manufactured by Yarnall-Waring Co., Chestnut Hill, Philadelphia, has just been received.

ELECTRIC HOUSEHOLD APPLIANCES manufactured by General Electric Co., Schenectady, N. Y., are illustrated in a new circular from that company.

MURRAY SPECIALTY MFG. CO., 55 West Woodbridge St., Detroit, Mich., is sending out its latest catalog, entitled, "Boiler Feed—How to Regulate It."

CATALOG NO. 100, on the subject of Westcott's lathe chucks and Little Giant drill chucks, manufactured by Westcott Chuck Co., Oneida, N. Y., has just been received.

THE LAGONDA MFG. CO., of Springfield, Ohio, has just published a booklet entitled, "Lagonda Boiler Room Specialties." This booklet describes and illus-

trates the company's several types of boiler tube cleaners with latest improvements and boiler quick repair tools. It also covers Lagonda automatic cutoff valve and multiple strainers. A copy may be had on request.

A NEW CATALOG and pricelist is just out from the Thomas P. Ford Co., 410 Broome St., New York City, giving full description and prices of the 4 D specialties. These include high and low pressure damper regulators, compound steam traps, reducing valves for steam, air and water, pump governors and pressure regulators, balanced tank valves, bypass valves, and controlling devices. All are clearly illustrated by sectional views and fully described. There is much interesting information on the sizes, prices and performances of the different devices.

FAESSLER BOILER MAKERS' Tools is the name of a new catalog just issued by the J. Faessler Mfg. Co., Moberly, Mo., specialists in boiler tool manufacture. This catalog fully illustrates and describes many types and sizes of boiler tube and superheater flue expanders —sectional and roller—for hand or power operation. It also shows Faessler's flue cutting tools and machines, countersinking tools, etc.

WHEEL LATHE EQUIPMENTS are described and illustrated in Leaflet No. 3482-A, just issued by the Westinghouse Electric & Mfg. Co. The class of work performed by these equipments is of special nature owing to the fact that hard spots are frequently encountered, and unless cut at low speeds, the tool is apt to break. Such conditions call for an efficient control system, which is supplied in these equipments.

Trade Notes

AT THE PANAMA-PACIFIC International Exposition, one of the most interesting and attractive displays is that of The Foxboro Co., in the great Machinery Palace, located in section 22, corner of Third Ave. and Ave. C2.

There is on exhibit here the full line of instruments manufactured by this company, including recording gages for permanent installation, portable recording gages, differential recorders, orifice meters, liquid level recorders, siphon gages, independent gage movements, pressure gages, improved recording thermometers, portable thermographs, recording hygrometers, indicating dial type thermometers, indicating electric pyrometers, portable and stationary tachometers and tachographs, revolution counters, mechanical and electrical time recorders, Durand radial planimeters and other scientific instruments used in and about power plants. The exposition is in charge of A. F. Mundy.

THE VILTER MFG. CO., Milwaukee, Wis., reports the following among recent installations: The Frigonifico Montevideo Sociedad Ammonia, Montevideo, Uruguay, 35,000 ft. of 2-in., full weight, lap welded, black steel, ammonia expansion piping; The Rahr Brewing Co., Green Bay, Wis., a 65-ton refrigerating plant; Redlands Ice & Cold Storage Co., Redlands, Cal., a 40-ton refrigerating plant; the Pittsburgh Lodge No. 46, Royal Order of Moose, Pittsburgh, Pa., a 12-ton refrigerating plant; The Gund Brewing Co., Cleveland, Ohio, 1 brine tank, 21 ft. by 8 ft. 6 in. by 7 ft., 14 coils of ammonia condenser coils 18 pipes high by 19 ft. long, also 1400 ft. of 1½-in. galvanized brine piping for cistern room; The Cuban Telephone Co., Havana, Cuba, a 26-ton water cooling plant.

THE INDIANA STEEL CO. has installed "Diamond" soot blowers, built by the Diamond Power Specialty Co., Detroit, Mich., on its 26 Rust boilers at Gary, Ind. The Diamond Power Specialty Co. reports that the percentage of its business specified by consulting engineers in the past year shows a wonderful increase over the previous year.

WILLIAM SIEBENMORGAN, formerly Chief Engineer of the C. & C. Electric & Mfg. Co., of Garwood, N. J., is no longer connected with that company, his resignation having taken effect early in February.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH

SEMI-MONTHLY

Subscription price in advance in the United States. Mexico or united possessions, $1.00 a year.

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Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 So. Dearborn St., Chicago, Ill.

Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

ADVERTISING RATES

Display

Full page, one year, each insertion, $60.00.
Half page, one year, each insertion, $35.00.
Quarter page, one year, each insertion, $20.00
Eighth page, one year, each insertion, $12.00
Front cover, $150.00 per issue.

Other specified positions, regular rate plus 10 to 50 per cent.

Stippled plates used, but no heavy, black and white plates.

Classified Rates

Per line, 30 cents each insertion.

Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 23,000

Technical Publishing Co.
537 S. Dearborn Street
Chicago

Position Wanted

POSITION WANTED—By engineer with years of experience in ice and electric light plants. Understand both a.c. and d.c. machines. Am a graduate of one of the best colleges in Middle West. A1 references. Ezra D. Dumas, Clarinda, Iowa. 4-1-2

POSITION WANTED—By I. C. S. student as oiler in a steam electrical plant where there is a chance for advancement. Some experience with steam. Age 27. Address Frank Knapp, 404 So. Fifth St., St. Joseph, Mo. 4-1-2

POSITION WANTED—As chief engineer in a small or medium sized plant. Twelve years' practical and technical experience in operation and maintenance of steam, electric refrigerating, pumping and condensing equipment. First class license. Married; age 30. Employed. Address Practical Engineer, Box 392, Chicago, Ill. 4-1-2

POSITION WANTED—By young man with 10 years' practical experience from boiler room up. Hold first class Massachusetts engineer's license. Will go anywhere. Am total abstainer and can furnish A1 references. Address Practical Engineer, Box 393, Chicago, Ill. 4-15-1

POSITION WANTED—As assistant engineer; experienced; I. C. S. student; best references; strictly sober; hold first class licence; will consider small salary if advanced as merited. Address Robert Pieper, Bloomington Prairie, Minn. 4-1-2

POSITION WANTED—By young man, age 21, as oiler or helper in power plant. A. S. C. graduate, electrical course. Some experience small gas engines. Would work a while for experience. Address O. W. House, Rush Springs, Okla. 4-1-2

POSITION WANTED—By licensed engineer, age 30. Good mechanic. 10 yr. experience. Can furnish A No. 1 references. Chicago preferred. Address Box 390, Practical Engineer, Chicago, Ill. 4-1-2

POSITION WANTED—As engineer in a small plant or assistant in medium sized plant. Experienced with steam a.c. and d.c. machines. Member N. A. S. E. Strictly sober. Indiana preferred. Address G. A. Van Horn, La Fayette, Ind. 4-15-1

Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga., Cincinnati and Columbus, Ohio, Kansas City, Mo., Los Angeles, Calif., Louisville, Ky., Newark, N. J., New Orleans, La., Portland, Ore., St. Louis, Mo., San Francisco, Calif., Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

FREE ENGINEERING BOOKS and power plant tools and specialties for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Address Practical Engineer, Subscription Department, Chicago, Ill. tf.

WANTED—Representatives to cover territory more thoroughly. Boiler room necessities. Liberal commissions. Old established house. Apply by letter. H. F. Maurel, 534 W. 22nd St., New York City. 4-1-3

WANTED—Engineer to sell automatic water regulators for steam boilers; can act as local agent; must be able to install. Eckel Hydrostat Co., 460 Mt. Elliott Ave., Detroit, Mich. 4-15-2

WANTED—Salesman of Mill and Engineer Supplies to handle sideline. No competition. Liberal commission. Room 28, Durant Block, Portland, Maine. 4-15-1

WANTED—Agents to sell my Graduated Calipers, Pocket Levels, etc. Liberal commission. Ernst G. Smith, Tampa, Fla. 2-1-6

Help Wanted

WANTED—Sales Engineer. Successful concern, established eighteen years, highest standing in its line in the United States, wants a Sales Engineer. Only first-class salesmen having had experience in engineer lines considered. Our product a necessity in every boiler plant. Price averages $250 per boiler. Sold on absolute guarantee. Exclusive territory allotted. Cash advances on trial orders will finance you if you have the ability. Positively give details about yourself in first letter. All correspondence held strictly confidential. Address Box 391, Practical Engineer, Chicago, Ill. tf.

WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put in on test at our expense with any grate made. Address Armstrong Mfg. Company, Springfield, Ohio. tf.

WANTED—Agents handling engine and boiler-room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Address Practical Engineer, Box 381, Chicago, Ill. tf.

For Sale

FOR SALE—Alternators and oil engines: 150 k.v.a G. E., form "P," 60 cy., 2300 v., with exciter and switchboard, $900; 150 k.v.a. Wghse., 60 cy., 220 v., 2 ph., with exciter and switchboard, $900; 75 k.v.a. Allis-Chalmers, 60 cy., 220 v., 3 ph., with exciter and switchboard, $550; 80 hp. De La Vergne twin cylinder oil engine, $1500. Duzets & Son, Hudson Terminal Bldg., New York. tf.

FOR SALE—18x42 in., 85 revolutions, 15-ft. dia. flywheel, 115-lb. automatic cutoff Corliss Engine, built by Reynolds, E. P. Allis Co. In good condition; can be seen running up to April 30. Will sell right, as we will discontinue that plant. A. H. Weinbrenner Co., Milwaukee, Wis. 4-15-1

FOR SALE—Steam Hammer, 750-lb. Bement Niles; excellent condition; will sacrifice to move quick. Have large stock machinery of all kinds. Send us your inquiries. Zelnicker Supply Co., St. Louis, Mo. tf.

FOR SALE—Machinery. All sizes new and second-hand Pulleys, Belting, Shafting, Hangers, Couplings, Pillow Blocks, Collars, etc. Passman Bros., 28 and 30 So. Green St., Chicago, Ill. 3-15-6

Patents and Patent Attorneys

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Bldg., Washington, D. C. tf.

PATENTS THAT PROTECT AND PAY—Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for search. Watson E. Coleman, Patent Lawyer, 624 F St., Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

PATENTS—Send sketch for free search and report. Books on patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Educational and Instruction

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee, will be mailed every subscriber sending in NEW subscriptions (not your own) to Practical Engineer. Gilt edges; bound in leather.

Micellaneous

FREE GASKET INFORMATION—Know why an annealed copper gasket is stronger and better than an unannealed gasket. Write the Akron Metallic Gasket Co., 152 N. Union St., manufacturers of Akron Corrugated Copper Gaskets, Akron Steel Gaskets, Akron Lead Gaskets, Akron Copper Asbestos Filled Gaskets, Akron Copper Asbestos Ribbed Gaskets, Akron Steel Asbestos Gaskets for boilers, Rubber Gaskets and Compressed Asbestos Gaskets. 4-1-2

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineerini Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

Sparks From The Advertising Pages

Advertising manufactured commodities benefits the producer, the middleman and the consumer. Most people know that. But many are to be found who, while admitting the tremendous selling force of advertising, will deny that any advantage accrues from it to the "ultimate consumer"— the man who "foots the bills."

The reasoning of such people usually finds expression thus: Advertising is so much expense added to the manufacturing and other costs of the article in question. Now, the consumer pays for all the material costs and service costs that go into any manufactured article, and, consequently, he pays for the advertising of it, too.

This, of course, is true. But the statement overlooks a very important factor in the problem, and in so doing is virtually a fallacy. It is assumed that the consumer, in paying the cost of advertising, derives no benefit therefrom; that an article, when it is not advertised, costs so much and when it is advertised, costs as much, together with the additional (prorated) expense of advertising it — expense for which the buyer receives no value.

But there are several important respects in which the consumer is benefited by the advertising of an article.

Without advertising, many articles which people value highly would be unknown to them. And not only that. Advertising also enables the public to discriminate in the selection of articles — to weigh comparative merits and so to obtain that which is best adapted to individual use and taste. Is not this a service to which value must be assigned in considering the total cost of an article?

But more important still is the consideration that it is the best brands of goods that are advertised, and that the mere fact that an article is advertised serves as a guarantee of quality to the consumer. There are doubtless exceptions to this rule, but they are few and unimportant. An advertiser's business sense tells him that to advertise articles without merit is a sure way to waste money. Now, is not this item of protection in buying advertised goods, of some pecuniary value to the consumer?

However, these advertising "values" do not compare in importance with this consideration: Advertising tends to cut down the price of manufactured articles. A manufacturer, let us say, turns out and sells annually, without advertising, one thousand of his product. By advertising it, he may increase sales to 2,000 or 3,000 with comparatively little additional outlay for labor and equipment. The cost of the product is reduced in spite of advertising expenditure, and, of course, also, the price to the consumer. We say "of course," because in competition with his rivals, the manufacturer finds it to his interest to make the price of his product as low as is consistent with business prudence.

The reader of Practical Engineer's advertising pages will readily admit the force of these considerations. There is unquestionable "educative" value in these announcements, especially to the reader who obtains and assimilates the literature offered freely by our advertisers. Nor, when the character of the advertisements is studied, will it be doubted that they amply sustain the argument that it is the "best goods" that are advertised — and that these are the cheapest, too, when quality is weighed along with price.